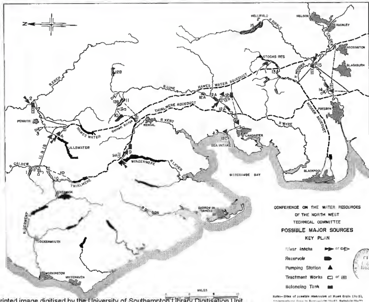


CONFERENCE ON THE WATER RESOURCES
OF THE NORTH WEST
TECHNICAL COMMITTEE

POSSIBLE MAJOR SOURCES
KEY PLAN

River intake ▶▶ or ▷▷
Reservoir ⬟
Pumping Station ▲
Treatment Works ☐ or ⊞
Balancing Tank ■

Note:—Sites of possible reservoirs at Howe Grain (No 5), [illegible] in Borrowdale (No 8), [illegible] (No 7)

REPORT TO THE MINISTER OF HOUSING AND LOCAL GOVERNMENT

1. In submitting this Report on behalf of our Conference I am discharging a task which was given me by your predecessor when I was Joint Parliamentary Secretary at the Ministry of Housing and Local Government. You are of course well aware of the nature of this work and of its origin. However I should perhaps briefly recapitulate the past history.

2. In November 1961 the Manchester Corporation deposited a Bill in Parliament, Part III of which sought authority to abstract water from Ullswater and to construct a reservoir in the Bannisdale Valley. The two projects were designed to provide up to 45 million gallons a day (m.g.d.) for the future needs of the Corporation and for the extensive area about them that they are obliged to supply with water. Petitions were laid against this part of the Bill by:

The Cumberland County Council
The Westmorland County Council
The Lake District Planning Board
The Cumberland River Board
The Lancashire River Board
The Lakes Urban District Council
The Penrith Urban and Rural District Councils
The Lakes and Lune Water Board
The Council for the Preservation of Rural England, The Friends of the Lake District, the Commons, Open Spaces and Footpaths Preservation Society, the Ramblers' Association, the Youth Hostels Association (England and Wales), the Workers' Travel Association Ltd., the Holiday Fellowship Ltd., the Co-operative Holidays Association, the Fell and Rock Climbing Club of the English Lake District, and the Cyclists' Touring Club
The National Trust for Places of Historic Interest or Natural Beauty
The Ullswater Preservation Society
The National Farmers' Union
The British Hotels and Restaurants Association
The Cumberland and Westmorland County Branches of the Country Landowners' Association
The Ullswater Navigation and Transit Company Ltd.
Mr. Richard Fothergill
Mrs. Sylvia McCosh; Miss Joan Mabel Howard and the Honourable Hubert Howard.

3. The Bill was strongly opposed when on February 8th, 1962 its second reading was moved in the House of Lords. The House eventually decided that Part III should be excluded.

4. Shortly after the vote in the House of Lords the Ministry sent a letter to the National Parks Commission, the Cumberland and Westmorland County Councils, the Lake District Planning Board and the Cumberland and Lancashire River Boards telling them that the Minister had decided to accept a suggestion from the Manchester Corporation that consultations should be arranged between these bodies and the Corporation and inviting their co-operation. The object, the letter explained, would be: "not to reach conclusions about the merits of the Ullswater and Bannisdale projects" but "to examine the various points which have been in dispute since the Corporation had published their proposals and to provide as far as possible a basis of agreed fact which would be helpful to all parties in considering further proposals from the Corporation when these are made". The letter went on to suggest that the chief points to be examined in the Minister's view were:

(*a*) the extent and probable timing of Manchester's needs—such needs including not only those of the Manchester area but those of the other neighbouring water undertakings which Manchester supplies in bulk;

(*b*) possible alternative sources of supply;

(c) any detailed objections to such schemes as might be suggested as alternatives to the Ullswater and Bannisdale schemes—as well as the objections already made to these latter two schemes.

The suggested consultations were generally acceptable and I was asked to preside over the proceedings.

5. The first meeting of the Conference was held on March 27th last year in London. Further meetings have been held there and in Preston and Manchester. At the first meeting the Conference accepted the objectives set out in the Department's letter of invitation and decided to set up two working Committees.

(a) A *Technical Committee* composed of water engineers or consultants nominated by all the authorities represented at the Conference and by the principal water undertakers entitled to receive water in bulk from Manchester. It was agreed that this Committee should estimate the extent and timing of the Corporation's needs, taking into account possible economies in the use of both industrial and domestic water. It was further agreed that the Committee should consider all reasonable alternative sources to those proposed by Manchester, giving priority in their investigations to sources outside the National Park, but not excluding sources within the Park. Mr. A. R. Vail, a Senior Engineering Inspector of the Ministry was nominated Chairman.

(b) An *Amenity and Planning Committee.* It was agreed that this Committee should consider the amenity and planning aspects of all proposals which the Technical Committee might develop in addition to the Ullswater and Bannisdale schemes. It was also to consider ways and means of improving public access to Thirlmere and its gathering grounds. It was agreed that Mr. J. L. Parkinson, the Ministry's deputy Chief Planner should be Chairman—and that the Corporation, the National Parks Commission, the Lake District Planning Board and the Westmorland and Cumberland County Councils should nominate representatives—either elected members or officers or both.

6. The final reports which have been agreed by the Technical Committee and the Amenity and Planning Committee are attached as Annexes A and B. Their conclusions—the fruit of much study, discussion and of visits to all the principal sites concerned—form the basis of the present report. The facts and opinions as presented by the Committees and broadly accepted by our Conference are as follows:

NEEDS

7. Manchester's obligations as water undertakers are twofold. In the first place they have an obligation to supply water direct to consumers in detail, like any other water undertaking. This obligation, however, now extends beyond the city boundaries and covers an area five to six times that of Manchester proper. The area contains a population of nearly 1,350,000, rather more than double that of the city itself. Secondly, in addition to these direct obligations to consumers, the Corporation has had ever since 1879 a statutory obligation to provide water in bulk to neighbouring water undertakings. The Act of that year which authorised the Corporation to abstract water from Thirlmere required them to supply water on demand to any water undertaking whose district was situated in the neighbourhood of the Thirlmere-Manchester aqueduct. Similarly when in 1919 Manchester acquired powers to take water from Haweswater, Parliament imposed a further and wider obligation to allow any water undertaking within five miles of the Thirlmere and Haweswater aqueducts or any water undertaking whose limits of supply are adjoining those of Manchester's own water undertaking to reserve a right to a bulk supply, subject to certain limitations. The present liability to supply in bulk amounts to about 27 m.g.d. Consequently in estimating the future needs of the Corporation it is necessary to take account not only of estimated increases in the area of direct supply but also of increases in the needs of the "dependent" water undertakings. Fourteen water undertakings at present receive part of their supplies from the Corporation. It has been necessary to consider in these cases what local sources may be available to meet part of this increase.

8. Accordingly the first action of the Technical Committee was to call for estimates of future needs not only from Manchester but also from the other water undertakings which Manchester supply or may be called upon to supply with water in bulk, as well as details of the existing and potential resources which they might be able to exploit themselves, thus reducing their present or future dependence on water

from Manchester. The Committee examined these estimates with close attention to see if they appeared reasonable. Natural and planned population changes were taken into account as well as the general increase in water consumption. Enquiries were made, too, about the methods employed in each area for detecting waste in unmetered use and for imposing economies on industry. It was found that up-to-date measures for the detection of waste as practised generally by efficient undertakings were in operation in these areas and should keep the loss of unmetered water within proper bounds. The question of industrial consumption was more difficult. It could not be examined solely in the context of Manchester and the other areas supplied by the Corporation. The amount consumed depended essentially on the nature of the industry. Anything like an imposed general reduction might do serious damage to individual industries and it was thought to be beyond the powers of any single water undertaking to decide what was appropriate in each case and to refuse to supply any more. Industrial consumption was not noticeably heavier in Manchester than in other, comparable, areas and it seemed impossible to require anything further from the Corporation or the neighbouring undertakings under this head.

9. The average daily consumption of water in 1961 in the areas supplied *direct* by Manchester Corporation was about 86 m.g. and in the remainder of the region drawing bulk supplies from the Corporation it was on average 168 m.g. The total consumption was therefore about 254 m.g.d.

10. The estimates for the future submitted by Manchester and the bulk supply authorities showed that by 1970 this total consumption might have increased to 313 m.g.d. and that thereafter it might rise fairly uniformly on average to 480 m.g.d. by 2,000.

11. Although such an estimate of the future needs of this region for water might at first sight appear high, the figures are in fact closely in line with the rising curve of water consumption in this area, and, more generally, throughout the country. The Committee concluded that although long-term estimates of demands cannot be precise the increases forecast were as accurate as possible and certainly not too high in the reasonably short term—up to 1985 or thereabouts. In view of this they decided that they should first consider the means of providing for the needs over the next twenty years or so.

12. The reliable yield of all the present sources available to the region (including one project—Wet Sleddale—still under construction) was found to be 276 m.g.d. To this had to be added a figure to represent what might be obtained from any new local sources that might be available.

13. The Committee came to the conclusion that in order to make proper provision for future needs Manchester ought to be seeking powers to develop new sources forthwith. They formed the opinion that Manchester and the dependent water undertakings may need additional water, if a dry year occurs, between 1965 and 1970. They also considered that after 1970 there would certainly be a deficit which would, unless offset by new sources of supply, rise to about 50 m.g.d. in 1985 and perhaps to around 110 m.g.d. in the year 2,000. The Committee accordingly thought that it would be prudent for Manchester to make immediate plans for securing an additional 50 m.g.d. They noted that at present the Haweswater storage is not fully used and that there is unused carrying capacity of about 50 m.g.d. in the Thirlmere and Haweswater aqueducts. This figure had therefore two important considerations behind it. It represented the estimated requirements for a reasonably short-term period and the additional capacity of Manchester's existing works.

14. We agree with these conclusions of the Technical Committee and consider that:

(*a*) the estimated trend of future needs (as shown in the Appendix E to Annex A) is reasonable although not precise in the long term;

(*b*) the estimated yield of new sources available to the region is as accurate as possible;

(*c*) it would be right for the Corporation to plan now to cover their future needs and a scheme or schemes giving a yield of some 50 m.g.d. should constitute the immediate target.

NEW SOURCES

15. A variety of new sources were suggested from different quarters after Manchester first published their own proposals. Inevitably these were not of equal value and some of them offer no solution to Manchester's present needs. One proposal which has had wide publicity is the distillation of sea-water.

The Technical Committee obtained estimates from one of the leading makers of distillation plant in this country on the capital and running costs. Briefly it is plain that water obtained in this way might cost as much as 10s. 0d. per 1,000 gallons, i.e. over six times the normal. The technique of distillation is no doubt continually improving and we recognise that cost will tend to fall, but there is little chance of a material fall in the near future. Manchester could not therefore be expected to regard distillation as a practicable method of obtaining water to meet the immediate objective. Another proposal has been outlined for the abstraction of underground water (at the rate of 100 m.g.d. or more) from the upper Eden Valley—the work to involve artificial replenishment of underground water storage and the use of a projected canal to be known as the Grand Contour Canal which would ultimately distribute water over a wide area of the country. That portion of the canal needed between the upper Eden Valley and Manchester was estimated by the proposer to cost £30 million, a figure regarded by the Technical Committee as on the low side. The amount of underground water actually available from this source is held by Geological Survey to be highly doubtful and a great number of boreholes and many miles of mains would be needed. It has, thirdly, been suggested that water might be brought from Scotland. But nothing like a firm scheme had been presented to the Committee. The extra cost of the aqueduct and pumping plant needed to bring water from Scotland over this extra distance would be £6 or £7 million and it would increase the cost of water by at least 1s. 0d. per 1,000 gallons. Fifty million gallons a day would therefore cost an extra million pounds a year. The Committee rejected the above projects as impracticable.

16. It has been contended by the opponents of the Ullswater and Bannisdale schemes that alternative sources should not be rejected because they might be more expensive. The Conference fully accepts that this is a valid point provided it is weighed in the balance against the needs of other interests including those of all consumers of water.

17. The Committee considered every feasible source of supply in the North West of England. Enquiries were also made about the possibility of drawing temporary bulk supplies from Liverpool if Manchester should have found no new source by 1965 when their deficit threatened. The Liverpool Corporation, while willing to do all they could in that event, were unable to give any positive assurances even for so small a quantity as 5 m.g.d. as a temporary supply.

18. Four classes of permanent source were considered by the Technical Committee:

Underground sources
Reservoirs in the Pennines of Lancashire, Cheshire and Derbyshire
Reservoirs (or lakes) in the Lake district
Rivers, with or without regulating reservoirs, in North West England.

19. It is plain that very little can be expected from underground sources or from new reservoirs in the Pennines. The Technical Committee have studied the geology of the counties of Lancashire, Westmorland and Cumberland, and have taken advice from Geological Survey. The geological formations of these areas vary greatly but none is capable of producing a large and lasting supply of underground water. Apart from such small amounts of ground-water as might be extracted by the local water undertakings little can be expected and the Corporation must unquestionably look to surface water, i.e.—to abstraction from rivers or to new reservoirs for their supplies. For these purposes the Pennines have virtually nothing to offer. They are already fully exploited by Manchester (the Longdendale reservoirs) and many Lancashire and Yorkshire towns.

20. There remain the other two classes—the larger rivers (with or without regulating reservoirs) and reservoirs or lakes in the Lake district. From these the Technical Committee have located 12 possible sources. In estimating yield, cost, and technical merits and demerits they have taken account of all the available information about geology, rainfall, river flows and other relevant data. Their findings, except those relating to Ullswater and Bannisdale which have been fully investigated, go as far as they believe to be possible without the detailed local investigations which only a water undertaking could carry out and without which there could be no absolute certainty that a particular source can be developed to produce a stated quantity of water at a stated cost. Subject to this qualification the Committee have estimated in each case the amount of water that might be produced, the capital cost and the cost of

running (including treatment) and have noted any special technical difficulties and/or advantages each scheme may present.

21. A detailed account of each source is given in their consolidated report—appended. It seems sufficient here firstly to record the Committee's opinion that there are "about a dozen potential major sources" which could, subject to further investigation, be developed either singly or in combination to give the required amount of water: and, secondly to list the sources.

They are the following:

Ullswater and Bannisdale which the Committee are agreed could, from a technical point of view be developed as Manchester have proposed.

Windermere where water could be supplied in two projects—a smaller one of 12 m.g.d. and a larger one producing additional water up to a total of 50 m.g.d. The Technical Committee have also outlined a possible third scheme (not studied by the Amenity Committee) which would yield perhaps 150 m.g.d. from Windermere.

Caldew Valley
Borrowbeck Valley } where new impounding reservoirs could be constructed.

River Eamont
River Eden } from which water could be abstracted.

River Lune
River Ribble } for which a number of alternative projects are shown in the consolidated report.

22. In all cases appropriate treatment would be given to the water, the nature of this treatment and the plant required for it being dependent on the quality of the water produced at the source.

Similarly balancing reservoirs, pumping stations, pipe-lines and other ancillary works would be needed to suit the circumstances of each case.

23. In view of our terms of reference neither the Conference nor the Technical Committee have tried to determine the relative merits of the various schemes considered. But the Committee have endeavoured to collect all the relevant ascertainable facts. They emphasise that although they have made the best possible estimate of the yields and costs of the various schemes they cannot be certain of these, because of the many unknown factors that must be taken into account. Geological conditions (except in the case of the Ullswater and Bannisdale schemes) are not precisely known and in most cases there are uncertainties about such things as river board requirements, agricultural, highway and other land interests. Moreover before finally choosing a particular project or projects it will be necessary to have regard not only to yield, cost and effects on amenity but also to the quality of the water and its suitability for domestic and industrial use either alone or in admixture with existing supplies. Manchester will have also to consider very carefully the time that different projects will take to complete. Something will depend on the time needed to obtain the powers. But apart from this there is not a lot of difference between the different projects considered, except for two. *Ullswater* would require less preliminary work. The smaller of the two *Windermere* projects is an easier, faster, engineering operation.

AMENITY AND PLANNING

24. The Amenity and Planning Committee have considered all the projects remitted to them by the Technical Committee including some which were ultimately excluded from the latter Committee's final list of recommended sources. They have considered also of course the two schemes, Ullswater and Bannisdale, for which Manchester originally sought powers. Altogether this Committee have examined 24 projects (some of them variations on a single source) and reported against 13. As they say in the final report their approach and the procedure which they have followed has been uniform throughout. They started off with the data likely to affect the physical appearance of each of the sources, furnished by the Technical Committee; they have visited each site and endeavoured to decide whether the alterations involved were acceptable having regard to the scale and nature of the landscape and also to the importance of the area for public access and enjoyment. They did not take the view that a project should *ipso facto* be rejected because it lay within a National Park or conversely that there would be no objection if it lay outside. They have sought rather to consider each case individually on its merits and decide

whether the physical changes it would impose are or are not tolerable in that particular context in the light of all the circumstances; they have had constantly in mind that in the case of a National Park the purpose of designation was preservation, and enhancement of natural beauty and the promotion of the enjoyment of the area by the public. They have also considered the other aspects of physical planning apart from amenity, including the effect on good agricultural land.

25. Broadly, however, the objections which the Committee have registered are objections affecting the amenities—i.e. that there was some alteration involved which would change the landscape significantly for the worse. The class of schemes most obviously open to this criticism are those which would flood valleys to create large impounding reservoirs. Thus the Committee reported against a Borrowdale reservoir (above Derwentwater) as one which would altogether transform a valley of great natural beauty and transform it for the worse. They have reported also against similar schemes affecting the Bannisdale, Duddon and Howe Grain valleys. In other places where the landscape is unremarkable the Committee have concluded that a reservoir, even a large one, might make little difference to the scene. Thus a suggested reservoir at Hellifield on the Ribble is thought unobjectionable from the amenity point of view. There was no question here of land being lost to public access and enjoyment; in fact, considered from that angle the change might be an improvement. Another reservoir, in the valley of the River Caldew near Mosedale, was also classed as acceptable "subject to the satisfactory siting of the dam and the provision of public access to the head of the reservoir".

26. The other main category of scheme is for abstracting water from existing rivers and lakes without damming. Here the change on the landscape is one of relative albeit possibly significant detail rather than total transformation viz. the alteration of water levels, the possible effect of such alteration on trees and grass, and the appearance of pipe-lines, pumping-houses and storage reservoirs. The Committee has not totally rejected any scheme of this class on amenity grounds alone (the four projects of abstraction from the River Lune also encountered strong agricultural objections). But they have felt obliged in expressing approval to do so with reservations—because the merit of the project from their point of view depended on details which could mar it if they were not satisfactorily managed.

27. The chief projects in this class which call for separate mention in the report are those for abstraction from Windermere (two schemes—a large and a small) and of course the original Ullswater scheme.

28. As regards Windermere, the Committee found both the schemes which they considered acceptable in principle. Their chief concern was that there should be no material alteration in the levels of the lake. This was not found to be a danger in the smaller scheme. But they are only able to accept the larger scheme provided that nothing in it should have this effect and that the water level in the river between Newby Bridge and the lake should be maintained. They consider also that in either scheme the position of the intake would have to be carefully selected—and that the pump-house and balancing reservoir would need careful siting and designing.

29. The question of Ullswater is more complex.

This is a lake unique in its unspoilt beauty—set in outstandingly fine country. There are a number of important questions here. First of all, what visible work is involved in pumping water from the lake? Secondly, what would be the visual effect produced by a weir? Thirdly, what would be the effect on the appearance of the lake produced by any temporary changes in level that would result from the abstraction of water either with a weir or without one, including the effect of changing levels on the marginal vegetation of the lake and finally would there be noise from the pump-house and if so would it be disturbing?

30. Taking these questions in order the Committee was satisfied that the proposed works (at Gale Bay) necessary for abstracting, pumping and transmitting the water by pipe-line could have little or no effect on the landscape and need not be harmful. They felt that the weir above Pooley Bridge, in the position proposed would seriously damage one of the best known of all views of Ullswater. A weir below the bridge, although affecting the flow of water, would be much less harmful.

The changes in lake levels brought about by any of these proposals (i.e. with or without weirs) are, the Committee found, small. Any injury to amenity would be due to possible ecological disturbance from interference with the natural rise and fall of the lake level. On this the Committee obtained a report from the Nature Conservancy. The majority conclude that the report corroborates their view that it is possible that vegetation around the lakeside might suffer and this could cause some injury to amenity. Some members, however, did not agree with this conclusion and point out that the Conservancy's report itself suggests that important permanent changes are improbable. On the question of noise the Committee thought that this might destroy the peace and quiet of a considerable part of the lake unless effective measures were taken to eliminate it.

CONCLUSIONS

31. It was never the purpose of the Conference to agree upon a single scheme or group of schemes to recommend to Manchester but rather to agree about the Corporation's requirements and to consider hopeful alternatives to the Ullswater and Bannisdale projects. It is thought that these limited objectives have been achieved. There should now be no question about the amount and urgency of Manchester's need for more water—or any doubt that the necessary works should be put in hand without delay if the Corporation, and those authorities which depend on the Corporation in this respect, are to avoid the situation in which a drought or a series of dry years might produce a serious shortage of water at some time after 1965.

32. There are a number of alternative sources from which these established needs could be met—either singly or in combination. This report and its Annexes say all that it is thought possible to say under this head.

33. The Manchester Corporation must, in the final resort, make their own choice. In doing so they will clearly wish to take into account the views which have been expressed, from the standpoint of amenity and planning, by this Conference on the Ullswater and Bannisdale schemes and on the other possible sources which we have considered. They will also no doubt wish to bear in mind the desirability of developing a scheme or schemes which will give rise to the minimum of justifiable opposition. At the same time we realise that they will have to balance these considerations against others, in particular the need to select a project or projects which can produce water in time to meet the shortage that threatens from 1965 onwards. It is our hope that the facts and data as agreed and presented in this report and its Annexes will assist the Corporation in their eventual decision and help everyone when considering proposals which Manchester may make without of course restricting their freedom of action.

34. The Conference wish to take this opportunity of thanking the members of their two Committees for much hard and patient work. Likewise they wish to acknowledge the debt they owe to their Secretary, Mr. B. A. F. Enright.

JELLICOE.

February, 1963.

ANNEX A

REPORT OF THE TECHNICAL COMMITTEE

COMMITTEE MEMBERS

A. R. Vail, Esq., B.Sc., M.I.C.E., M.I.W.E. (*Chairman*)

J. F. Bailey, Esq., A.M.I.C.E., M.I.W.E.
R. H. Cuthbertson, Esq., B.Sc., M.I.C.E., M.I.W.E.
H. R. Davenport, Esq., M.I.C.E., M.I.W.E.
G. B. Dearden, Esq., B.A., Dip.T.P., A.R.I.B.A., A.M.T.P.I. (*Co-opted*)
R. L. Harrison, Esq., B.Sc., M.I.C.E., M.I.W.E.
T. E. Hawksley, Esq., B.A., M.I.C.E., M.I.W.E.
R. le G. Hetherington, Esq., O.B.E., M.A., M.I.C.E., M.I.W.E.
R. Jackson, Esq., B.Sc., A.M.I.C.E., M.I.W.E.
J. Kennard, Esq., B.Sc., M.I.C.E., M.I.W.E.
F. Law, Esq., B.Sc., M.I.C.E., M.I.W.E.
A. S. Riley, Esq., B.A., A.M.I.C.E., A.M.I.W.E.
R. D. Robinson, Esq., B.Eng., M.I.C.E., M.I.W.E.
A. E. Round, Esq., B.Sc., A.M.I.C.E., A.M.I.W.E.
N. A. F. Rowntree, Esq., B.Sc., M.I.C.E., Pres. I.W.E.
W. D. Yale, Esq., B.Sc., A.M.I.C.E., A.M.I.W.E.
R. Wyllie, Esq., M.I.C.E., M.I.W.E.

INTRODUCTION

1. At the first Conference on March 27th, 1962, the terms of reference given to us were:
    - (i) to consider and report to this Conference on the extent and probable timing of the future needs of the Manchester water undertaking and those water undertakings which Manchester supply, or may be called upon to supply, with water in bulk and the water resources available to meet those needs;
    - (ii) to consider and report to this Conference whether there are any ways in which economies in the use of water can reasonably be adopted within the water limits of those undertakings;
    - (iii) if the technical committee reach the conclusion that further major resources will be needed to meet the needs as determined under (i) above to consider and report to this Conference on all feasible sources to meet those needs, taking into account the requirements of water undertakings in Cumberland and Westmorland or other areas affected.

2. We have held four meetings as a body and in addition there have been many meetings of smaller groups each entrusted with the detailed investigation of particular subjects.

3. Our first concern was to establish, as accurately as possible, the quantities of water likely to be needed in future in the region which depends for supplies wholly or partly on sources owned by Manchester Corporation and the extent to which the demands could be met from the existing resources of the water undertakers concerned or from potential new sources within their areas. Appendices A and B

4. For this purpose a questionnaire was sent to forty undertakings and replies were received from all but six whose possible demands are of little significance.

The replies to the questions asked were carefully examined before being used in our calculations.

5. We then made an assessment of the future total needs of the region up to the year 2000 and by comparison with the existing and potential local resources were able to establish the size of the deficiency that would have to be made up by development of new sources. Appendix D

6. The next step was to consider how the required quantities of water could be obtained and to make estimates of the cost of constructing and operating the necessary works.

7. As our investigations have proceeded we have submitted, from time to time, four interim reports and we now present this final report embodying the contents of those earlier ones.

PRESENT CONSUMPTION (1961 *basis*)

8. In Manchester's statutory area the present day water consumption, by a population of about 1,350,000, averages just over 86 million gallons a day (m.g.d.).

Metered consumers take an average of about 46 m.g.d. and the remaining 40 m.g.d. are accounted for by domestic consumption, unmetered trade use, miscellaneous usage and losses from mains and fittings. The metered consumption is equivalent to 33·9 gallons per head per day (g.h.d.) and the unmetered supplies represent 30·4 g.h.d. and give a total, for all purposes, of 64·3 g.h.d.

Appendix C In 1961 some 18 m.g.d. were supplied in bulk to other undertakings in the region making a total supply of 104 m.g.d. Manchester's liability for such supplies under statute or agreement amounts at present to abour 27 m.g.d.

9. The other water undertakings serve a total of 3,275,000 people and supply an average of 168 m.g.d. of which 57 m.g.d. are metered. Industrial consumption, represented by the metered supplies, is as high as 32 g.h.d. in places and is equivalent to 17·4 g.h.d. for the combined areas. Unmetered consumption per head varies from 25 g.p.d. to 44 g.p.d. but averages just under 34 g.p.d.; one of the highest figures being that for the Blackpool area where the needs of large numbers of summer visitors are included in the total.

10. In the first report of the sub-committee of the Central Advisory Water Committee on the Growing Demand for Water the estimated daily consumptions of water per head in England and Wales in 1965 were given as likely to be 21 gallons for metered supplies and 31 gallons for unmetered water; for the North Western Administrative Region the quantities were 28 and 31 gallons respectively.

WASTE DETECTION

11. In Manchester's supply area the detection of waste is a continuous operation involving the use of waste meters, night sounding of mains, inspection of fittings and other recognised means. As a result, while metered demand per head has increased threefold during the present century, unmetered consumption has barely doubled and has remained fairly steady during the past 20 years in spite of inclusion in the statutory area, from time to time, of additional districts in which waste prevention had previously been neglected.

12. In most of the other supply areas with which we are concerned in our investigations we are satisfied that, although some waste of water occurs in places, waste detection is reasonably well carried out and total losses are not abnormal having regard to such local factors as mining subsidence.

13. We consider it would be beyond our power, in the time available to us, to make any assessment of the ways in which industry could economise in the use of water. The complexity of the problem has been recognised by the "demands" sub-committee who, in their first report, produced in 1959 and referred to above, said that "information is not readily available on methods of industrial water conservation now in use or being developed in this country".

14. Although much industrial use is made of local streams and underground water resources recent experience has shown that there is an increasing demand for good quality mains water and there is no reason to suppose that this state of affairs will not continue.

15. We have found that none of the water undertakers in north-west England has powers to compel economy in industrial water use and we are, moreover, extremely doubtful whether the exercise of any such powers would be in the national interest. Section 27 of the Water Act 1945 requires water undertakings to supply water for non-domestic purposes provided their ability to meet existing obligations and future domestic demands would not thereby be endangered and we are of the opinion that it is right that an undertaker should, if he can do so at reasonable cost, take the necessary steps to provide such industrial supplies as are called for.

16. We have, however, looked into the extent to which water undertakers in the area are in contact with their metered consumers and we are satisfied that in most cases they do what is possible to encourage economy in the use of water and are ready to give advice on methods of reducing consumption where this is asked for or appears to be necessary.

FUTURE DEMANDS

17. Careful consideration has been given to the demands for water that can be expected in the immediate and more distant future. Each water undertaking has been asked to make estimates of requirements and these have been examined to make sure that they have been based on acceptable principles.

18. The Planning Officers of the Ministry of Housing and Local Government have been consulted on population trends and, although accurate forecasting of the population of any particular water area may be extremely difficult because of possible migration or planned movement of people, it is thought that for the area as a whole the estimates for the future are not unrealistic.

19. The needs of industry are incalculable as so much depends on technical developments, productivity and other unknown factors and it has been necessary to project recent trends. The effect of this, in Manchester's area, is that the estimated metered consumption for the year 2000 is about 96 m.g.d. which is practically 50 m.g.d. more than at present.

20. For unmetered supplies it has been assumed that improved housing, with a higher proportion of hot water systems, baths and water closets, and greater use of automatic washing machines and similar appliances will result in increased domestic consumption and an "unmetered" demand, by the year 2000 A.D., of about 45 g.h.d. for the whole region.

21. The resulting estimate is that the quantity of water needed for all purposes will rise to about 313 m.g.d. in 1970 and thereafter, fairly steadily, to some 480 m.g.d. in 2000. Appendix A

WATER RESOURCES

22. The estimates of the reliable yield of Manchester's sources have been examined and the yield of Longdendale and Thirlmere have been agreed at 24 m.g.d. and 36 m.g.d. respectively.

After the completion of the Wet Sleddale reservoired intake, now in hand, the gross yield of the Haweswater works will be 80 m.g.d. and, although there is some doubt about the allowance that should be made for the complicated compensation water provisions of the 1919 Act, it is considered reasonable to assume that 71 m.g.d. will be available for supply.

The value of a reservoir in Swindale, for which powers exist, has been considered and it is agreed that it might produce a further 4 m.g.d. but would be very expensive for such a small yield.

It may, therefore, be taken that the total quantity of water that will be available to Manchester is about 131 m.g.d.

23. The existing sources of the other water undertakings are estimated to be capable of producing 145 m.g.d. so that the quantity of water that can be relied on for the region as a whole is about 276 m.g.d.

24. Local resources have been considered by the water undertakers and there appear to be some fifty potential sources, of various types and of yields of up to 10 m.g.d., that could possibly be brought into use. Appendix B

These sources, of which details are set out in Appendix B, might together produce about 106 m.g.d. Enquiries have been made about twenty-three of the sources that are not yet under construction and it appears that there is doubt about five of them estimated to give nearly 11 m.g.d. In the case of the other eighteen sources, with a potential yield of 49 m.g.d., further exploratory work would be needed and the normal procedure of preparing schemes and obtaining the necessary powers for the construction of works would have to be followed.

ADDITIONAL WATER REQUIRED

25. We consider that although long-term estimates of demands cannot be precise it would be unwise to assume that those for the shorter term are too high. It would also be dangerous to assume that all

the potential local sources could be successfully developed or that surplus water in one locality could be transferred to another area where there was a shortage.

Appendices E and H Further, some allowance must be made for abnormal demands in the dry years when sources are giving their lowest yields.

We have thought it right to add to the estimated average demands in the future a percentage to allow for undistributable local surpluses, abnormal demands in dry years and other unknown factors.

We have found it impossible to be definite about the appropriate allowance but for purposes of Appendix E we have used a figure of 5 per cent.

26. We accordingly estimate that the region should have sources capable of producing, under the worst conditions, 329 m.g.d. in 1970, 388 m.g.d. in 1980, 445 m.g.d. in 1990 and 504 m.g.d. in 2000.

27. The Fylde Water Board and the Preston and District Water Board had been, for some time before we started our deliberations, investigating three possible reservoirs for regulating the flow in the River Hodder so that quantities of 40 m.g.d. or more could be taken from it.

Because of the difficulty of introducing this large quantity into our water balance sheet without giving a misleading impression we decided that it would be necessary to disregard both the needs and the resources of the two boards in order to arrive at a realistic estimate of the short-term needs of Manchester and the other water undertakers.

The assumption made was that up to 1980, at least, the two boards would be able to obtain from their own sources all the water they required.

28. As a result we have formed the opinion that Manchester and the dependent water undertakings may need additional water, if a dry year occurs, between 1965 and 1970 and that the deficiency may increase thereafter to about 50 m.g.d. in 1985 and to around 110 m.g.d. in 2000.

29. The Thirlmere aqueduct has a capacity of 48 m.g.d. but can carry up to 53 m.g.d. if the flow is boosted by pumps.

The capacity of the tunnel sections of the Haweswater aqueduct south of Garnett Bridge is 105 m.g.d. while the connecting siphons, on completion of the third line of pipes, will have a combined capacity of 85 m.g.d.

The Thirlmere and Haweswater aqueducts are connected, near Garnett Bridge, by the Sprint siphon which can carry 30 m.g.d. and has at times been used to transfer Haweswater water to the Thirlmere aqueduct. It can be used to pass 10 m.g.d. in the reverse direction by pumping.

The total potential carrying capacity of the Thirlmere-Haweswater system of aqueducts will therefore be 153-158 m.g.d. south of the Sprint siphon once the fourth Haweswater pipeline is laid and that quantity is 46-51 m.g.d. greater than the combined reliable nett yield, of 107 m.g.d., of Manchester's present Lakeland sources, including Wet Sleddale.

30. We consider it would be prudent for Manchester to make immediate plans for securing an additional source or sources capable of providing about 50 m.g.d.—a quantity that agrees closely with the spare carrying capacity of the combined Thirlmere and Haweswater aqueducts when fully developed.

MAJOR NEW SOURCES

31. In seeking means of obtaining additional water we have, on the whole, concentrated on sources which appear to be capable of a yield of 15 m.g.d. or more.

The main reason for this is that, as a generalisation, it can be said that the larger the source the cheaper the water and it would probably prove to be uneconomic to develop a large number of small sources especially if they were scattered over a wide area.

32. We have considered, as a first step, four groups of possible sources, namely,

(*a*) underground sources;
(*b*) reservoirs in the Pennines of Lancashire, Cheshire and Derbyshire;
(*c*) reservoirs in Cumberland and Westmorland, and
(*d*) rivers, with or without regulating reservoirs, including the Eden, Lune, Ribble and Wyre.

33. In connection with underground sources we have studied the geology of the region and have taken the advice of the Geological Survey. Much of the north-western part of the area lies on impermeable granites and slates and in south and south-east Lancashire there are the Coal Measures which do not contain much water. The Carboniferous limestones of the northern Pennines contain much water at times but are generally drained to the rivers; the grits of the southern part of the range are interspersed with impermeable shales and do not offer large supplies of water. The Permo-Triassic rocks around Carlisle, in the Fylde and Southport areas and in Cheshire are generally covered by a considerable thickness of drift material and are not very productive although they have been much exploited both by public water undertakings and by industry. Certain alluvial gravels might provide small supplies of water that would otherwise flow into rivers.

34. We have received two suggestions that underground water could be tapped in large quantities.

On July 10th, 1962, Mr. P. Liddell of Moorhouse Hall, Warwick-on-Eden, near Carlisle, wrote to ask whether we would be prepared to consider certain matters put forward by a geologist and was told that we would welcome constructive suggestions about means of obtaining 15-50 m.g.d.

Mr. Liddell replied that the geologist in question was abroad and was expected back later in the month but so far nothing further has been heard from him.

35. On August 23rd, 1962, a letter from Mr. J. F. Pownall was received by the Water Engineer and Manager, Manchester, and passed to us.

Mr. Pownall enclosed a memorandum on an outline proposal to abstract ground water at the rate of 100 m.g.d. or more from the New Red Sandstone and Carboniferous Limestone formations in the upper Eden valley.

The necessary works, ultimately to form part of the "Grand Contour Canal", to deliver the water to a point near Bolton are estimated by Mr. Pownall to cost £30m. but his costs are probably very low for the present day.

He admits that "the successful development of underground water reserves has somewhat the hazards of a mining venture".

On the subject of ground water in the area to the east and north of the Lake District the Geological Survey say that "in the Carlisle basin a state of balance presumably exists and effective percolation of rain water into the ground must be negligible".

If percolation were induced by pumping from the aquifers it is extremely unlikely that 100 m.g.d. could be obtained because of the character of the local Permo-Triassic and Carboniferous formations and because of extensive boulder clay covering.

Even if such a quantity could be obtained "many hundreds of boreholes" scattered throughout the catchment would be needed, any abstraction would be at the expense of river flows and some of the water would be exceedingly hard.

Artificial recharge of the aquifers from the rivers in times of high flows would require a great number of borings and might not be successful.

In view of this geological report, the very great capital and running costs of the scheme, and the necessity for a feeder canal, 50 miles long from Sedbergh to Ribchester, we have not pursued this proposal.

36. We are satisfied that there is no prospect of obtaining large quantities of water from underground and as such further abstraction as appears to be possible has been included under the heading of "local resources" we have carried this particular investigation no further.

37. In our opinion the Pennines of Lancashire, Cheshire and Derbyshire have been fully exploited or would be if the few remaining reservoir sites, for which allowance has been made under "local resources", were developed. It is certain that there is no major source available in the locality.

38. We were therefore left with possible reservoirs elsewhere in north-west England and the rivers. Appendix O

We have found a dozen potential sources and have given careful thought to the ways in which they could be developed. We have prepared estimates of yields and costs with due regard to all circumstances so far as they can be determined without a great deal of field work which we are not able to undertake and without which there could be no certainty that a particular source could be developed to produce a stated quantity of water at a stated cost.

On the tabulated statement, Appendix G, we have given some details of the possible sources and have noted any special technical merits or demerits that each may have.

The precise requirements of parties interested in river flows are not available in all cases and certain assumptions have had to be made so that the yield of the source could be estimated.

In view of the uncertainty about the treatment of Thirlmere and Haweswater waters that may later be required no alteration of the present treatment of those waters has been assumed in assessing the costs of the various schemes.

39. The value to be placed on the quality of the water obtainable from a source is not easy to assess. Much depends on the use to which the supply is to be put and on the quality of the water, from sources already in use, with which it will be mixed. A water suitable for domestic consumption may not be satisfactory for certain industrial purposes.

We have received letters from Imperial Chemical Industries Limited stating that they take over 3 m.g.d. from Manchester Corporation at Blackley and Trafford Park and a similar quantity from the Fylde Water Board at Fleetwood.

They give a list of the maximum quantities of various substances that are permissible in the water they use and they stress the importance of the quality of supplies to the Company in the north-west of England.

To quote from paragraph 128 of the Final Report of the Sub-Committee on the Growing Demand for Water "the treatment of unsuitable water to make it suitable for industrial purposes can be very costly, often more so than treatment for potability".

40. Briefly the schemes, in geographical order from north to south, are as follows:

In the *Caldew* valley an impounding reservoir could be constructed, with or without auxiliary intakes on local streams, to collect water for delivery to either the Haweswater or the Thirlmere reservoir. From an intake on the *Eamont* or the *Eden* water could be taken to balancing reservoirs and pumped to Haweswater.

Ullswater could be used as a source from which water would be pumped to a catch-water feeding Haweswater reservoir. Abstraction could be made with or without a low adjustable weir whose function would be to control the flow of water from the lake and so to provide storage.

The pumping of water from *Windermere* when the flow of water to the river Leven was not less than a prescribed amount would be feasible. For average daily quantities up to 12 m.g.d. the water could be pumped direct into the Thirlmere aqueduct where this passes close to the eastern shore of the lake but for additional quantities, up to a total of 50 m.g.d., the water would have to be piped to Garnett Bridge and discharged into the Haweswater aqueduct.

In *Bannisdale* an impounding reservoir could be constructed and used in conjunction with an intake on the Borrowbeck, near High Borrow Bridge, to provide water to be piped to the aqueduct near Garnett Bridge as proposed under Manchester's abortive Bill.

On the *Borrowbeck* itself an impounding reservoir could be constructed between High Borrow Bridge and the confluence with the River Lune. The natural yield of the reservoir could be increased by pumping to it water from an intake on the Lune near Tebay and the water would ultimately be passed to the aqueduct system near Garnett Bridge.

The *River Lune* could be developed as a source by the construction of an intake below Kirkby Lonsdale and either storage reservoirs on the flood plain or river regulating reservoirs in the valleys of tributaries such as Borrowbeck, Hindburn, Roeburn, etc.

A further possibility would be abstraction from the river just above the lowest existing weir at Skerton and augmentation of the residual flow down the estuary by sea water pumped from an intake constructed in Morecambe Bay.

In all cases the water for supply would be pumped into the Haweswater and/or Thirlmere aqueducts.

The *River Ribble* similarly offers possibilities of development by means of intakes and storage or regulating reservoirs.

The storage reservoirs would be on the flat riverside land in the Ribchester area; the regulating reservoirs would be on the headwaters of the River Hodder, in the Dunsop, Langden and Croasdale valleys, or on the Ribble itself near Hellifield; and the intakes would be near Great Mitton where the Hodder joins the Ribble.

Water would be pumped into the areas of supply of the Fylde and Preston Boards, but if the Hellifield scheme were adopted there would be a sufficient yield to enable water also to be pumped into the Haweswater aqueduct for Manchester.

In addition to the above there were one or two possible schemes, such as that involving a large impounding reservoir in Borrowdale, which we discarded because while having technical advantages they appeared to have overriding disadvantages on amenity grounds.

41. For any scheme, except those involving Bannisdale or Ullswater, a period of about two years must be allowed for making detailed investigations, carrying out necessary negotiations, and obtaining enabling powers either by Parliamentary Bill or by Minister's Order.

Design and construction of works of the type envisaged would take three or four years.

It is probable, therefore, that in most cases a total period of five to six years would elapse before a scheme could be brought into use.

These estimates assume normal progress and make no allowance for delays that might well arise at any stage.

42. We have had the benefit of a talk with the Regional Land Commissioners concerned with the sites of potential major sources.

They expressed the view that there would be minimal effect on agricultural interests at the Caldew, Eamont, Ullswater, Windermere, Bannisdale and Borrowbeck sites, but that more serious consequences would arise from the construction of reservoirs in the Eden, Lune and Ribble valleys.

In connection with the Hellifield scheme on the Ribble it was stated that fifty farms would be affected to a greater or lesser extent and that the flooding of 2,500 acres of land, rated locally as extremely good and producing grass and hay for dairy herds, would be a serious loss to agriculture.

43. We have therefore made no attempt to place the sources in order of merit; and indeed we doubt whether it would be desirable that we should attempt to do so.

MISCELLANEOUS SOURCES OF WATER

44. It was suggested to us that reduction of the quantities of compensation water paid out from impounding reservoirs would make more water available for supply. This, of course, is true. Appendix F

A study was accordingly made of the situation with regard to compensation water in the area of the Mersey River Board and the result is shown in tabular form on Appendix F.

Ten water undertakings own 61 impounding reservoirs in the area and the compensation water discharged from them to the streams amounts to some 37 m.g.d. which is 37·2 per cent of the estimated reliable gross yield of the sources.

It will be noted that Bolton Corporation pay out over 57 per cent of the yield of their reservoirs, whereas Manchester's sources in Longdendale and adjoining valleys contribute about 30 per cent of their yield to the Mersey.

It is true that when the compensation water provisions of the enactments authorising the construction of the reservoirs were drafted the waters of the various streams were used to a great extent for power and process purposes in numerous mills along their courses; whereas today many of the mills are closed down or no longer used for such water consuming purposes as bleaching and dyeing, and other forms of power are used extensively.

If the quantity of compensation water were reduced to 25 per cent of the estimated yield in all cases there would be an additional 12 m.g.d. available for supply.

For this to be done all the authorities concerned would have to get Parliamentary powers for the reduction, unless the agreement of all interested parties was obtained, and this would probably prove to be a difficult and slow process with much opposition from the River Board and riparian owners.

In other parts of north-west England the compensation water provisions are probably less onerous to the water undertakings and any reduction of quantities would be less profitable but probably no less difficult to obtain.

While we consider that the subject of compensation water discharges is of great importance and that a review of water undertakers' liabilities in this connection is needed we do not think it offers a practical means of quickly augmenting supplies to the undertakings.

45. Distillation of sea water has been suggested, on a number of occasions, as a means of obtaining the additional water required by Manchester.

The Corporation Water Department recently obtained from G. and J. Weir Ltd., Glasgow, one of the leading makers, a quotation for the provision of a "vacuum flash" distillation plant and an estimate of the cost of running it.

The capital cost of a plant capable of producing 2·5 m.g.d. was given as £640,000 or £256,000 per million gallons a day. For twenty units to produce 50 m.g.d. the cost would be of the order of £12,800,000.

The annual capital and operating costs were given as:

		pence/thousand gallons
Fixed charges (amortisation, labour, chemicals, etc.)		21
Fuel costs—steam	16·6	
electricity..	20·4	
		37
Total		58

These annual charges were based on the assumption that the plant would be operated for 350 days a year, in association with an electric power station from which steam and electricity could be obtained at the following rates:

High pressure steam	10s. per ton
Low pressure steam	3s. per ton
Electricity	0·85d. per unit

We have been in communication with the Central Electricity Generating Board about the possibility of operating a distillation plant of 30 m.g.d. or 50 m.g.d. capacity in conjunction with a power station in the coastal areas of Cheshire or Lancashire.

Their Chief Planning Engineer informs us that it is unlikely that the price of low pressure steam would, in the circumstances envisaged, be less than 12s. to 15s. per ton and that a figure of 0·85d. per k.w.h. for electricity is likely to be obtained only under favourable conditions and with steady consumption throughout the major part of the year.

If that is so the cost of water distilled would increase considerably and might well be doubled.

Moreover, there would be the cost of the sea intake, pre-treatment plant, pumping plants and aqueduct, at least 30 miles long, to carry the water to Manchester and although these might add only a few pence per thousand gallons to the cost of the water they would call for additional capital expenditure of about £4m.

Finally, there would be the small cost of attendance on, and power for, the pumps.

A continuous supply costing anything up to 10s. per thousand gallons is not, in our opinion, a practical proposition in this country and the chances of the cost of de-salted water falling appreciably in the near future are slender.

In the United States, where vast sums of money are being spent on research into methods of desalination, current technical opinion is that the cost of fresh water produced from the sea is unlikely to fall to 50 cents per thousand U.S. gallons, under the most favourable conditions, for a good many years to come.

46. Another suggestion is that water should be obtained from an unspecified source in Scotland. We have noted that the nearest point in Scotland is over 30 miles, as the crow flies, from Haweswater and we have calculated that the cost of the aqueduct and pumping plant required to deliver the water to Manchester's works at a rate of 50 m.g.d. would be £6m. or £7m. and the capital and running costs

would be equivalent to about 1s. per thousand gallons or £1m. per annum. This would be merely the *extra* cost over and above the cost of collecting and treating the water and delivering it from Haweswater into supply.

We have not considered the suggestion in any greater detail.

TEMPORARY MEASURES

47. We have given thought to ways in which the quantity of water available to Manchester and the dependent undertakings might be increased temporarily bearing in mind the folly of embarking on constructional works of no permanent value.

The most promising source appeared to be the Tryweryn scheme at present under development by Liverpool Corporation.

We have been in communication, through Mr. J. H. T. Stilgoe, M.I.C.E., the Water Engineer, with the Liverpool Water Committee who passed a resolution in the following terms:

(i) if the Tryweryn reservoir is available in 1965 for use in accordance with the provisions of the Liverpool Corporation Act 1957 it is estimated that the Liverpool Corporation will have a surplus in the River Dee at Huntington in that year of about 40 million gallons a day; and

(ii) the surplus will diminish thereafter according to the demands on that Corporation's water undertaking; and

(iii) the Corporation is prepared to consider making a supply available to Manchester Corporation but only as a temporary measure and in so far as this will not prejudice any requirements of both the Corporation and the other water authorities which formed the basis of the Corporation's application to Parliament for the powers now contained in the Liverpool Corporation Act 1957.

This resolution was confirmed by the Council on July 25th, 1962.

48. It will be appreciated that Huntington is over 30 miles from Manchester and at least 20 miles from the nearest part of the Manchester water area so that to get any large quantity of Tryweryn water into supply the Corporation would have to construct a pumping station, treatment plant, pipeline and other works at a cost that would be prohibitive for a temporary supply.

There is the possibility that part of such works could form an advance stage of a scheme ultimately necessary to enable Liverpool to make use of the water but the complications involved would be considerable.

49. The simplest way of getting help from Liverpool appeared to be to take bulk supplies through existing or new connections to the aqueduct from the Rivington reservoirs to the Prescot service reservoirs.

The reliable yield of the Rivington works is not more than 10 m.g.d. and bulk supplies are given from them to several authorities so that at the best only a limited quantity could be hoped for by Manchester.

The Liverpool Water Committee were therefore asked whether, if by 1965-70 Manchester (not having completed the construction of a major additional water source) were in need of 5 m.g.d. or thereabouts for a year or two, Liverpool would be able and willing to afford a temporary supply of that order from the Rivington works.

The reply was to the effect that the Water Committee could not see how it would be possible to give us any assurance in response to our question as they foresaw difficulties in replacing any supply given until an additional pipeline had been laid in the Vyrnwy aqueduct between Norton and Prescot.

A resolution to this effect was passed by the Water Committee on September 18th, 1962.

50. The Lune Valley Water Board have powers to abstract up to 8 m.g.d. from the River Lune near Lancaster and own other sources capable of a reliable yield of 3·76 m.g.d. but their present total consumption is around 7 m.g.d.

By 1965 they might have, say, 4 m.g.d. to spare for a short period and it should be possible for this water to be pumped into the Thirlmere aqueduct without the construction of major works.

51. The taking of any temporary supplies that might be obtained from Liverpool, Lune Valley or elsewhere should, in our opinion, be regarded merely as an emergency measure and should not be considered as justification for delay in proceeding with the development of a permanent scheme.

GROUPING OF MAJOR SOURCES AND LONG-TERM MEASURES

52. Of the possible major water sources we have listed there are six each of which could produce the quantity of about 50 m.g.d. required to make full use of the Manchester aqueducts and meet the Corporation's short-term needs.

Appendix J The remaining seven sources, some of which have variations, could be grouped in pairs to produce quantities of water ranging from 27 m.g.d. to over 50 m.g.d.

Some sources could not be used in conjunction with certain others because they make use of the same storage or of the same aqueduct capacity.

It would be pointless to consider pairings that would yield less than, say, 40 m.g.d. and the formation of groups of three or more sources should be avoided if possible.

Neglecting the variations of individual sources and assuming average values for prescribed river flows there would be some fourteen pairs that would yield 40 m.g.d. or more but of these only seven would give 45 m.g.d.

The Borrowbeck scheme could be usefully associated with six others including the Caldew scheme which could itself also work in conjunction with the Ullswater schemes or the Eden or Eamont intakes.

The Bannisdale scheme would combine with six others but only three of the combinations would be sufficiently productive. In the case of the limited Windermere scheme only two out of seven possible pairings would be worth-while and those would be the one with Ullswater (with weir) and that with Borrowbeck.

It must be emphasised that Appendix J has over-simplified the situation in that only average source yields have been used in computing the group yields. For example, in the case of Ullswater, without weir (No. 4B), an average yield of 22 m.g.d. has been adopted whereas the range of yields, shown on Appendix G, is 15-29 m.g.d. Should the larger figure be possible the source could be put into more groups to give 40 m.g.d. or more.

53. We have shown that, if the estimates of future requirements prove to be accurate, Manchester and the dependent water undertakings will in the long run have need of quantities of water additional to the 50 m.g.d. required in 1985 or thereabouts.

By 1990 that extra quantity may be 18 m.g.d. and by 2000 it may rise to 61 m.g.d.

For the whole region, including the areas of the Fylde and Preston and District Water Boards, the total requirements in the year 2000 may be 228 m.g.d. in excess of existing resources and even if, by then, local sources yielding about 78 m.g.d. have been developed there will still be need for some 150 m.g.d.

54. In the event of the construction of the Hellifield reservoir to regulate the flow in the Ribble up to 100 m.g.d. could be taken from the river. This would suffice until about 1990.

55. We have also looked for other means of getting large quantities of water and have reached the conclusion that Windermere is one source with an appropriate potential.

With storage capacity of 20,000-35,000 m.g. water could be drawn from Windermere at times of high inflow and passed into supply at the rate of, perhaps, 100 to 150 m.g.d. which would be sufficient until 1990 or 2000.

We have looked at the valleys of the Gilpin and Winster and the estuaries of the Kent and Leven and, although detailed study would be necessary before a firm opinion could be expressed, it would seem possible that the necessary storage capacity could be created at one of the sites or by combining two others.

The water would have to be treated and pumped to a balancing tank and then gravitated through a new aqueduct to the southward for distribution as required.

Preliminary calculations suggest that the cost of the necessary works would be reasonable.

56. Should the Hellifield scheme and/or the full Windermere scheme be promoted it would be desirable

that each should be developed to the full for the benefit of the region as a whole and it would be necessary to decide which should be carried out first. This decision would have to be made very soon as construction work might have to start before 1970.

In the meantime the possibility of the use of Windermere as a source for the long-term affects the value of the lake as a short-term source because although the restricted Windermere scheme (No. 9A) for 12 m.g.d. could no doubt be carried out without appreciable influence on the full development of the source it would be necessary to consider what effect scheme No. 9, for 50 m.g.d., would have on a further development of the lake's potential.

CONCLUSIONS

57. To summarise, our conclusions are that:

(*a*) In the statutory water areas of Manchester Corporation and of other water undertakings in the north-west of England that the Corporation supply, or may be called upon to supply, with water in bulk a need for additional water may arise between 1965 and 1970.

The overall deficiency may rise to about 111 m.g.d. by the year 2000, or even to 150 m.g.d. if the needs of the Fylde and Preston boards are taken into account.

(*b*) There is no evidence that undue use or waste of water occurs in the areas to such an extent that their eradication would materially affect the water supply position to-day.

We know of no practical means by which, even if it were desirable, a substantial reduction in the use of water by industry could be brought about and we expect the consumption of water per head for domestic purposes to increase as the standard of living rises.

Accordingly we consider that the estimates we have made of future water requirements are appropriate for the next twenty years or so though they may prove to be less accurate as time goes on.

(*c*) We consider, after making due allowance for the development of local sources, that Manchester Corporation should make plans for the development, possibly by stages, of a source or sources capable of a reliable yield of about 50 m.g.d.

Such a yield should be sufficient for the next twenty-five years or so and would fully utilise the potential capacities of the tunnel and "cut and cover" sections of the Thirlmere and Haweswater aqueducts.

(*d*) We are of the opinion that there are about a dozen potential major sources that from the technical point of view could, subject to confirmation of the suitability of geological and other conditions, be developed to give, either singly or in combination, the required quantity of water.

(*e*) We reject as impractical suggestions that water, in quantities large enough to solve the region's problems, could be obtained by reduction of compensation water paid out from impounding reservoirs, by abstraction of ground water either with or without artificial recharge of the aquifers, by distillation of sea-water or by piping water from Scotland.

(*f*) For the long-term needs of the region there are, we think, at least two ways in which quantities of 100 m.g.d. or more could be obtained and they involve development of the resources of Windermere and regulation of the flow in the River Ribble.

ACKNOWLEDGEMENT

58. We tender our thanks to Mr. A. C. Berry of the Manchester Water Department, who has acted as secretary to the Committee, and the engineers and other gentlemen who have provided us with information or helped in other ways.

A. R. Vail
J. F. Bailey
R. H. Cuthbertson
H. R. Davenport
G. B. Dearden
R. L. Harrison
T. E. Hawksley
R. le G. Hetherington
R. Jackson
J. Kennard
F. Law
A. S. Riley
R. D. Robinson
A. E. Round
N. A. F. Rowntree
W. D. Yale
R. Wyllie

January, 1963

M = metered
U = unmetered
T = total
E = existing
P = potential future local

Present and Estimated Future Consumptions in million gallons per day

Ref. No.	Undertaking	1961			1970			2000			Resources		
		M	U	T	M	U	T	M	U	T	E	P	T
1	Accrington Dist. W.B.	1·20	2·20	3·40	1·54	2·83	4·37	2·15	3·97	6·12	2·22	1·20	3·42
2	Ashton-under-Lyne &c. J.W.C.	1·68	4·18	5·86	1·91	4·69	6·60	2·63	6·45	9·08	3·23	3·64	6·87
4	Fylde Water Board	9·99	15·70	25·69	16·00	20·00	36·00	33·60	33·00	66·60	21·20	30·75	51·95
5	Furness W.B.	3·20	4·24	7·44	3·50	5·50	9·00	5·00	7·00	12·00	8·10	9·00	17·10
6	Irwell Valley W.B.	1·59	5·32	6·91	1·92	5·76	7·68	2·55	7·65	10·20	5·71	1·34	7·05
7	Heywood and Middleton W.B.	0·95	2·65	3·60	1·00	3·00	4·00	1·20	4·20	5·40	4·97	0·35	5·32
8	Lakes and Lune W.B.	0·50*	2·00*	2·50*	0·55*	2·20*	2·75*	0·70*	2·80*	3·50*	1·86	—	1·86
9	Lune Valley W.B.	2·25	4·50	6·75	2·65	5·20	7·85	3·90	7·60	11·50	3·76	8·00	11·76
10	Macclesfield D.W.B.	1·00*	3·04*	4·04	1·40*	4·40*	5·80	2·90*	8·71*	11·61	3·94	3·30	7·24
11	Makerfield W.B.	4·00	8·20	12·20	7·65	9·35	17·00	10·20	13·30	23·50	5·00	5·40	10·40
12	Mid and S.E. Cheshire W.B.	4·24	6·49	10·73	5·10	7·80	12·90	8·00	12·00	20·00	12·10	3·25	15·35
13	North Calder W.B.	1·00	2·20	3·20	1·30	2·20	3·50	1·70	2·30	4·00	3·69	6·35	10·04
14	Preston and District W.B.	4·80	6·94	11·74	6·82	7·81	14·63	13·82	11·27	25·09	9·30	1·00	10·30
15	West Cumberland W.B.	0·60*	2·49*	3·09	0·70*	2·80*	3·50	1·00*	4·00*	5·00	4·86	3·00	7·86
16	Bacup Corporation	0·20*	0·80*	1·00*	0·20*	0·80*	1·00*	0·24*	0·96*	1·20*	0·90	—	0·90
17	Bolton Corporation	4·20	7·36	11·56	5·00	8·70	13·70	7·22	10·98	18·20	8·22	5·00	13·22
18	Burnley Corporation	1·54	2·14	3·68	2·67	2·58	5·25	4·65	4·35	9·00	3·00	3·00	6·00
19	Clitheroe Corporation	0·16*	0·70*	0·86	0·17*	0·72*	0·89	0·20*	0·82*	1·02	1·31	—	1·31
20	Darwen Corporation (now Fylde W.B.)	0·41	0·93	1·34	—	—	—	—	—	—	1·88	—	1·88
21	Oldham Corporation	3·37	6·29	9·66	3·60	7·00	10·60	3·90	9·20	13·10	10·48	1·00	11·48
22	Rochdale Corporation	1·15	4·48	5·63	1·25	4·42	5·67	1·25	4·22	5·47	6·17	—	6·17
24	Stockport Corporation (now S.D.W.B.)	2·50	8·30	10·80	4·08	12·92	17·00	5·92	17·39	23·31	9·40	8·60	18·00
25	Warrington Corporation	5·24	5·80	11·04	7·24	7·30	14·54	12·20	12·30	24·50	10·15	2·30	12·45
26	Adlington U.D.C.	0·03	0·13	0·16	0·03	0·14	0·17	0·04	0·19	0·23	—	—	—
27	Blackrod U.D.C.	0·02	0·13	0·15	0·03	0·17	0·20	0·05	0·27	0·32	0·18	—	0·18
29	Holmfirth U.D.C.	0·10*	0·52*	0·62	0·11*	0·56*	0·67	0·14*	0·70*	0·84	0·68	0·20	0·88
30	Horwich U.D.C.	0·09*	0·54*	0·63*	0·10*	0·60*	0·70*	0·10*	0·60*	0·70*	0·34	—	0·34
33	Oswaldtwistle U.D.C.	0·19	0·53	0·72	0·16	0·62	0·78	0·16	0·68	0·84	0·86	—	0·86
34	Padiham U.D.C.	0·11	0·45	0·56	0·11	0·56	0·67	0·19	0·64	0·83	1·03	—	1·03
36	Burnley R.D.C.	0·04	0·18	0·22	0·06	0·26	0·32	0·08	0·30	0·38	0·16	—	0·16
38	Chorley R.D.C.	0·51	1·01	1·52	0·68	1·02	1·70	0·85	1·50	2·35	—	—	—
40	North Westmorland R.D.C. }	0·20*	0·80*	1·00*	0·40*	1·60*	2·00*	0·40*	1·60*	2·00*	0·47	1·95	2·42
42	Penrith R.D.C. }												
43	Manchester Corporation	57·06 45·74	111·24 40·47	168·30 86·21	77·93 55·40	133·51 45·90	211·44 101·30	126·94 95·80	190·95 66·10	317·89 161·90	145·17 131·00†	98·63 7·00	243·80 138·00
		102·80	151·71	254·51	133·33	179·41	312·74	222·74	257·05	479·79	276·17	105·63	381·80

* Estimated only

† Including Wet Sleddale

APPENDIX B

Potential Local Sources

Undertaking	Source	Type	Yield	Remarks
			m.g.d.	
Accrington Dist. W.B.	Steiner works	R	1·20	Acquisition authorised
Ashton-under-Lyne, etc., Joint Committee	Dove Stone	R	3·64	Under construction
Fylde W.B.	Broughton-Garstang	W	20·00	Under construction
	Dunsop	W	0·75	
	R. Wyre	I	10·00	Not yet investigated
Furness W.B.	Two sites	W	5·00	Not yet investigated
	Levers Water	R	2·00	Not yet investigated
	River Duddon	I	2·00	
Irwell Valley W.B.	Musbury	R	0·48	Uneconomic
	Dearden Clough	R	0·86	Uneconomic
Heywood & Middleton W.B.	Chapel Lane	W	0·35	
Lune Valley W.B.	R. Lune	I	8·00	1st stage in use
Macclesfield Dist. W.B.	Lamaload	R	1·30	Under construction
	Alderley	W	2·00	
Makerfield W.B.	Various sites	W	5·40	Preliminary investigations
Mid. & S.E. Cheshire W.B.	R. Dee	I	3·25	Extension of existing scheme
North Calder W.B.	Three sites	W	0·60	
	Water Meeting	R	4·00	Geological conditions uncertain
	Wycoller	R	1·75	Geological conditions uncertain
Preston & Dist. W.B.	Smelt Mill	W	1·00	
West Cumberland W.B.	Crummock	R	3·00	Increased abstraction from lake
Bolton Corporation	Wayoh	R	2·50	Under construction
	Bradshaw	R	2·50	
Burnley Corporation	Worsthorne	W	0 60	Under development
	Cockden	W	0·15	Trial horing made
	Other sites	W	1·00	
	Thursden	R	1·25	Geological conditions doubtful
Holmfirth U.D.C.	Various sites	R	0·20	
Oldham Corporation	Butterworth Hall	W	0·40	Extra water from old pit
	Various sites	W	0·60	
Stockport Corporation (now S.D.W.B.)	Bramhall	W	2·00	
	Goyt	R	0·90	Modification of existing reservoir
	Errwood	R	2·70	
	Various sites	W	3·00	
Warrington Corporation	Frodsham	W	1·00	
	Kenyon	W	1·00	
	Lymm	W	0·30	Extra from existing borehole
N. Westmorland R.D.C.	Various	I	1·95	
			98·63	
Manchester Corporation	Shoulthwaite	I	3·00	In connection with Thirlmere
	Shelf	R	4·00	Not economic
			105·63	

Note: R = reservoir.
I = intake.
W = well or borehole.

APPENDIX C

Manchester Corporation's Bulk Supply Liabilities

Ref. No.	Undertaking	Reservation	Statutory Agreement	Terminable Agreement	Total Liability	Taken 1961
		m.g.d.	m.g.d.	m.g.d.	m.g.d.	m.g.d.
1	Accrington Dist. W.B. ..	0·660	—	—	0·660	0·660
4	Fylde W.B.	0·042	0·120	0·003	0·165	0·166
6	Irwell Valley W.B.	2·000	—	—	2·000	0·799
8	Lakes and Lune W.B. ..	0·020	0·402	0·382	0·804	0·045
9	Lune Valley W.B.	0·158	—	2·134	2·292	1·787
11	Makerfield W.B.	3·800	0·250	0·898	4·948	4·370
14	Preston & Dist. W.B. ..	2·500	—	—	2·500	2·347
17	Bolton Corporation	4·235	—	—	4·235	3·729
18	Burnley Corporation ..	0·500	—	—	0·500	0·103
24	Stockport Corpn. (S.D.W.B.)	3·000	1·100	—	4·100	1·975
25	Warrington Corporation ..	—	—	0·084	0·084	0·081
26	Adlington U.D.C.	0·100	—	—	0·100	0·096
38	Chorley R.D.C.	1·331	—	0·357	1·688	1·525
40	North Westmorland R.D.C.	1·000	—	—	1·000	0·513
	Knutsford & Bucklow R. ..	—	—	—	—	0·204
	1961 Totals	19·346*	1·872	3·858	25·076	18·400
	New reservations by— Preston (0·5) and Makerfield (1·3)	1·800	—	—	1·800	—
	1963 Totals	21·146			26·876	

Note: Of the total of reservations of 19·346 m.g.d. a quantity of 2·337 m.g.d. is in respect of Thirlmere (Act of 1879) and the remaining 17·009 m.g.d. are related to Haweswater (Acts of 1919 and 1956).

APPENDIX D

Details of Present and Estimated Future Demands and Resources in M.G.D.

Ref. No.	Undertaking	1961					1970					1980				
		Con-sumption	Own Supply Avail-able	Theoretical Surplus (+) or Deficiency (−)		Taken from Manchester	Esti-mated Demand	Own Supply Avail-able	Surplus (+) or Deficiency (−)		Possible demand on Manchester	Esti-mated Demand	Own Supply Avail-able	Surplus (+) or Deficiency (−)		Possible demand on Manchester
				+	−				+	−				+	−	
1	Accrington D.W.B.	3·40	2·22	—	1·18	0·660	4·37	3·42	—	0·95	1·0	5·25	3·42	—	1·83	2·0
2	Ashton-u-Lyne &c., J.W.C. ..	5·86	3·23	—	2·63	—	6·60	6·87	0·27	—	—	7·42	6·87	—	0·55	0·5
4	Fylde W.B. (incl. Darwen) ..	27·03	23·08	—	3·95	0·166	36·00	37·95	1·95	—	—	45·00	51·95	6·95	—	—
5	Furness W.B...	7·44	8·10	0·66	—	—	9·00	9·60	0·60	—	—	10·00	9·60	—	0·40	0·4
6	Irwell Valley W.B.	6·91	5·71	—	1·20	0·799	7·68	5·71	—	1·97	2·0	8·53	5·71	—	2·82	2·8
7	Heywood & Middleton W.B.	3·60	4·97	1·37	—	—	4·00	5·32	1·32	—	—	4·58	5·32	0·74	—	—
8	Lakes W.B.	2·50	1·86	—	0·64	0·045	2·75	1·86	—	0·89	1·0	3·00	1·86	—	1·14	1·1
9	Lune Valley W.B.	6·75	3·76	—	2·99	1·787	7·85	11·76	3·91	—	0·5	9·05	11·76	2·71	—	0·5
10	Macclesfield D.W.B... ..	4·04	3·94	—	0·10	—	5·80	5·24	—	0·56	0·6	7·79	7·24	—	0·55	0·5
11	Makerfield W.B.	12·20	5·00	—	7·20	4·370	17·00	5·50	—	11·50	0·2*	19·30	8·90	—	10·40	7·1*
12	Mid. & S.E. Cheshire W.B. ..	10·73	12·10	1·37	—	—	12·90	12·10	—	0·80	1·0	15·40	15·35	—	0·05	—
13	North Calder W.B.	3·20	3·69	0·49	—	—	3·50	3·69	0·19	—	—	3·80	4·29	0·49	—	—
14	Preston D.W.B.	11·74	9·30	—	2·44	2·347	14·63	10·30	—	4·33	3·0‡	18·66	10·30	—	8·36	3·0‡
15	West Cumberland W.B. ..	3·09	4·86	1·77	—	—	3·50	4·86	1·36	—	—	4·00	4·86	0·86	—	—
16	Bacup Corporation	1·00	0·90	—	0·10	—	1·00	0·90	—	0·10	—	1·00	0·90	—	0·10	—
17	Bolton Corporation	11·56	8·22	—	3·34	3·729	13·70	10·72	—	2·98	3·0	16·60	13·22	—	3·38	3·4
18	Burnley Corporation ..	3·68	3·00	—	0·68	0 103	5·25	3·75	—	1·50	1·5	6·11	4·75	—	1·36	1·4
19	Clitheroe Corporation ..	0·86	1·31	0·45	—	—	0·89	1·31	0·42	—	—	0·99	1·31	0·32	—	—
21	Oldham Corporation ..	9·66	10·48	0·82	—	—	10·60	10·88	0·28	—	—	11·50	11·48	—	0·02	—
22	Rochdale Corporation ..	5·63	6·17	0·54	—	—	5·67	6·17	0·50	—	—	5·53	6·17	0·64	—	—
24	Stockport D.W.B.	10·80	9·40	—	1·40	1·975	17·00	12·30	—	4·70	4·7	19·88	15·00	—	4·88	4·9
25	Warrington Corporation ..	11·04	10·15	—	0·89	0·081	14·54	10·15	—	4·39	3·4†	18·00	12·45	—	5·55	4·6†
26	Adlington U.D.C.	0·16	—	—	0·16	0·096	0·17	—	—	0·17	0·2	0·20	—	—	0·20	0·2
27	Blackrod U.D.C.	0·15	0·18	0·03	—	—	0·20	0·18	—	0·02	—	0·27	0·18	—	0·09	0·1
29	Holmfirth U.D.C.	0·62	0·68	0·06	—	—	0·67	0·68	0·01	—	—	0·73	0·68	—	0·05	—
30	Horwich U.D.C.	0·63	0·34	—	0·29	—	0·70	0·34	—	0·36	0·4	0·70	0·34	—	0·36	0·4
33	Oswaldtwistle U.D.C. ..	0·72	0·86	0·14	—	—	0·78	0·86	0·08	—	—	0·84	0·86	0·02	—	—
34	Padiham U.D.C.	0·56	1·03	0·47	—	—	0·67	1·03	0·36	—	—	0 74	1·03	0·29	—	—
36	Burnley R.D.C.	0·22	0·16	—	0·06	—	0·32	0·16	—	0·16	0·2	0·34	0·16	—	0·18	0·2
38	Chorley R.D.C.	1·52	—	—	1·52	1·525	1·70	—	—	1·70	1·7	2·04	—	—	2·04	2·0
40	Nth. Westmorland R.D.C. (incl. Penrith R.D.C.).	1·00	0·47	—	0·53	0·513	2·00	0·47	—	1·53	1·5	3·00	0·47	—	2·53	2·5
		168·30	145·17	8·17	31·30	18·196	211·44	184·08	11·25	38 61	33·9	250·25	216·43	13·02	46·84	37·6
				— 23·13					— 27·36					— 33·82		
43	Manchester Corporation ..	86·21	120·00			86·21	101·30	131·00			101·3	118·30	131·00			118·3
		254·51	265·17	Surplus		104·40 15·60	312·74	315·08	Deficiency		135·2 4·2	368·55	347·43	Deficiency		155·9 24·9
						120·00					131·0					131·0

Notes: * 3·3 m.g.d. taken from Liverpool. † 1·0 m.g.d. taken from Liverpool. ‡ Supply for power station, &c.

APPENDIX E

Summary of Estimated Demands and Resources

	1961	1970	1980	1990	2000
	m.g.d.	m.g.d.	m.g.d.	m.g.d.	m.g.d.
TOTAL DEMAND, in an average year	254	313	369	424	480
Add 5 per cent. for a very dry year and for local surpluses not distributable	—	16	19	21	24
MAXIMUM TOTAL QUANTITY to be provided ..	254	329	388	445	504
TOTAL YIELD OF EXISTING SOURCES (including Wet Sleddale after 1961)	265	276	276	276	276
DEFICIENCY..	—	53	112	169	228
Deduct new sources assumed to be developed by Fylde W.B. and Preston D.W.B. and 4 m.g.d. taken from Liverpool by Makerfield W.B. and Warrington Corporation		22	35	49	65
ADDITIONAL WATER REQUIRED by remaining undertakings		31	77	120	163
LOCAL SOURCES—possible yield, if developed ..		23	41	52	52
REQUIRED YIELD OF MAJOR NEW SOURCE/S ..		8	36	68	111

APPENDIX F

Compensation Water Paid Out from Reservoirs in the Mersey River Board's Area

Ref.	Undertaking	No. of Reservoirs	Yield (m.g.d.)			Compensation as percentage of Total
			Compensation	Supply	Total	
2	Ashton-under-Lyne and J.W.C. ..	7	2·062	3·778	5·840	35·3
6	Irwell Valley W.B.	7	2·727	4·536	7·263	37·5
7	Heywood and Middleton W.B. ..	5	2·410	4·510	6·920	34·8
10	Macclesfield D.W.B.	5	0·651	1·140	1·791	36·3
16	Bacup Corporation	3	0·366	0·895	1·261	29·0
17	Bolton Corporation	10	9·218	6·875	16·093	57·2
21	Oldham Corporation	5	3·249	6·468	9·717	33·4
22	Rochdale Corporation	7	2·593	3·577	6·170	42·0
24	Stockport D.W.B.	4	3·500	7·000	10·500	33·3
43	Manchester Corporation	8	10·440	24·000	34·440	30·3
	TOTALS	61	37·216	62·779	99·995	37·2

Preliminary Information Regarding Possible Sources in Cumberland River Board Area

No.	Scheme	Description	Assumed Abstraction Terms	Approx. Net Yield	Approx. Capital Cost	Approx. Cost per 1,000 gals.	Difficulties or Objections	Possible Advantages	Remarks
1A	River Caldew.	Impounding reservoir on River Caldew near Swineside. Water from reservoir then treated and pumped by pipeline via Pooley Bridge and Heltondale Aqueduct to Haweswater Reservoir.	5 m.g.d. compensation water to River Caldew at dam.	m.g.d. 16	£m. 5·5	pence 17·7	Effects of reduced flows in River Caldew.	—	Costs include treatment of Caldew water (16 m.g.d.) by micro-straining and chlorination prior to entering Haweswater Reservoir and also for further straining and chlorination at Garnett Bridge. Also included is the capital cost (£1·2m.) involved in increasing the capacity of Haweswater Outlet Works.
1B	River Caldew and Glenderamackin.	Impounding reservoir on River Caldew near Swineside. Inflow supplemented by pumping from intake on River Glenderamackin near Hazelhurst. Water from reservoir then treated and pumped by pipeline via Pooley Bridge and Heltondale Aqueduct to Haweswater Reservoir.	5 m.g.d. compensation water to River Caldew at dam. No abstraction from River Glenderamackin when flow is less than 3·5 m.g.d.	21	6·2	16·5	As in scheme 1A above.	Scheme suitable for development in stages.	Costs include treatment of combined Caldew and Glenderamackin water (21·0 m.g.d.) by micro-straining and chlorination prior to entering Haweswater Reservoir and also for further straining and chlorination at Garnett Bridge. Also included is the cost (£1·2m.) involved in increasing the capacity of Haweswater Outlet Works.
1C	River Caldew.	Impounding reservoir on River Caldew near Swineside. Pipeline via Glenderamackin and St. John's Beck to Thirlmere. Treatment at source.	5 m.g.d. compensation water to River Caldew at dam.	12 (Manchester) 4 (Cumberland)	2·92 0·75	11·7 —	Effects of reduced flows in River Caldew.	—	Costs assume treatment of Caldew water by micro-straining and chlorination.
1D	Rivers Caldew and Glenderamackin, Trout Beck and Mosedale Beck.	Impounding reservoir on River Caldew near Swineside and intakes on River Glenderamackin near Hazelhurst, Trout Beck near Lanehead and Mosedale Beck near Hill. Pipeline from reservoir via Glenderamackin to Hill and branch pipeline from Lanehead to Hill. Tunnel from Hill to Thirlmere. Treatment prior to entering Thirlmere.	5 m.g.d. compensation water to River Caldew at dam. No abstraction from River Glenderamackin, Trout Beck and Mosedale Beck when flows are less than 3·5 m.g.d., 2·45 m.g.d. and 2·25 m.g.d. respectively.	22	7·0	16·9	(As in 1C above.) Ajustment of terms of abstraction from River Glenderamackin, Trout Beck and Mosedale Beck.	Scheme suitable for development in stages.	Costs assume full treatment of Caldew, Glenderamackin, Trout Beck and Mosedale Beck waters (32 m.g.d.) and include the works required to increase the capacity of the aqueduct from Thirlmere to Sprint and for the power required to pump 10 m.g.d. to the H.A.

2	River Eden.	Abstraction from river at Edenhall. Two stage pumping, balancing reservoir and treatment. Main via Lowther Valley and Heltondale Aqueduct into Haweswater Reservoir.	No abstraction when flow below 150–301·5 m.g.d. depending on time of year. Abstraction suspended 20 days in year to pass freshets.	27	7·8	21·0	Effects on fishing interests. Use of land for 40 m.g. reservoir and sludge disposal. Hardness of water 150+.	Suitable for development in two stages.	Costs assume full treatment at source to avoid deterioration of Haweswater water and chlorination at Garnett Bridge. Also included is the capital expenditure (£1·7m.) involved in increasing the capacity of the Haweswater Outlet Works and of the H.A. to 86 m.g.d.
3A	River Eamont.	Intake on River Eamont near Tirril. Water pumped to Heltondale where it is treated and conveyed via Heltondale Aqueduct to Haweswater.	No abstraction when flow in river falls below 36 m.g.d.	32	6·5 (4·9)	15·3 (11·7)	Effect of intake and reduced flow in River Eamont on fishing interests.	—	Costs assume full treatment of water prior to entering Haweswater together with subsequent straining and chlorination with Haweswater water at Garnett Bridge. (The corresponding costs if treatment by micro-straining and chlorination is found to be adequate are given in brackets.) Also included is the capital expenditure (£2·6m.) involved in increasing the capacity of the Haweswater Outlet Works and of H.A. from Haweswater to Manchester to 91 m.g.d.
3B	River Eamont.	Ditto	No abstraction when flow in river falls below 51 to 102 m.g.d. depending on the time of year.	18	5·0 (3·5)	19·3 (13·8)	Ditto	—	Ditto, but including expenditure of £1·2m. to increase capacity of Haweswater Outlet.

GENERAL NOTES

1. It is assumed that the 3rd pipeline in the syphons on the Haweswater Aqueduct would be installed in any event, and the cost of a 4th pipeline only has been included in the above estimates to give a total aqueduct capacity equal to the requirements of each particular scheme.
2. It must not be assumed that two individual schemes can necessarily be combined or that if combined, the resulting yield would equal the sum of the two individual yields.
3. Schemes 2, 3A and 3B involve large river intakes. Such intakes would probably necessitate the construction of a weir across the river.
4. Sites for possible reservoirs at Howe Grain (No. 5), Andersonband Crag in Borrowdale (No. 6), Swindale (No. 7) and the Duddon Valley (No. 8) have not been investigated in detail as those reservoirs were considered to be unsuitable.

No.	Scheme	Description	Assumed Abstraction Terms	Approx. Net Yield	Approx. Capital Cost	Approx. Cost per 1,000 gals.	Difficulties or Objections	Possible Advantages	Remarks
				m.g.d.	£m.	pence			
4A	Ullswater with a weir.	Abstraction from lake at Gale Bay. Water pumped via Heltondale Aqueduct to Haweswater Reservoir. Treatment at Heltondale. Control of outflow from Ullswater by means of a moving weir.	(1) Prescribed flow at Pooley Bridge between 20 and 30 m.g.d. depending on lake levels. No abstraction when lake level is below 475·0. O.D. Freshets up to 250 m.g. per month in summer.	37	5·4	11·2	Effect of weir on lakeside interests, effect of reduced flow in River Eamont.	Scheme suitable for development in two stages. (First stage equivalent to scheme 4B.)	Costs assume treatment of water by micro-straining and chlorination prior to entering Haweswater together with subsequent straining and chlorination with Haweswater water at Garnett Bridge. Costs also include the capital expenditure (£3·0m.) involved in increasing the capacity of Haweswater Outlet Works and of H.A. (from Haweswater to Manchester) to 95 m.g.d.
			(2) Prescribed flow at Pooley Bridge between 42 and 85 m.g.d. depending on time of year. Freshets totalling 2,500 m.g. during year.	20	3·4	12·5	Effect of weir on lakeside interests.	Ditto	Costs assume treatment of Ullswater water by micro-straining and chlorination prior to entering Haweswater together with subsequent straining and chlorination with Haweswater water at Garnett Bridge. Costs also include the capital expenditure (£1·2m.) involved in increasing the capacity of Haweswater Outlet Works.
4B	Ullswater without a weir.	As 4A above but without a weir.	(1) No abstraction when lake level falls below 475·4. O.D. equivalent to an outflow of 30 m.g.d.	29	3·9	10·6	Effect of reduced flow in River Eamont.	—	As scheme 4A(1), but with capital expenditure (£1·9m.) to increase the capacity of the Haweswater Outlet Works and of H.A. to 88 m.g.d.
			(2) No abstraction when level in lake falls below that necessary to give outflows between 42 and 85 m.g.d. depending on time of year.	15	3·1	14·5	Effect of lower levels in lake due to abstraction.	—	As scheme 4A(2).

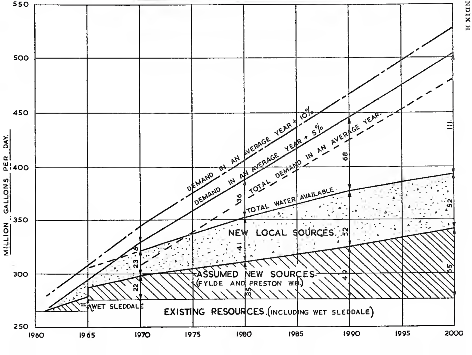
Preliminary Information Regarding Possible Sources in Lancashire River Board Area

9	Windermere	Intake N. Lake. Pipeline to Watchgate via balancing reservoir on Banner Rigg. Treatment at Watchgate. Water delivered to H.A. & T.A. (via new pipeline).	(1) No abstraction when flow in Leven is 30 m.g.d. or less. Maximum pumping rate= 70 m.g.d.	48	9·4	16·0	—	—	Costs allow for full treatment of Windermere water at the maximum pumping rates of 70 and 100 m.g.d. and for increasing strainer capacity at Garnett Bridge for Haweswater water from 71 to 105 m g.d. and also for a capital expenditure of £1·2m. for increasing capacity of Haweswater Outlet Works and Mardale tunnel plus £3·5m. for fourth line on all H.A. syphons between Watchgate and Manchester. Savings would later be effected if Haweswater water has eventually to be fully treated.
			(2) No abstraction when flow in Leven is 50 m.g.d. or less. Maximum pumping rate = 100 m.g.d.	48	11·3	18·2			
9(*a*)	Windermere (small scheme).	Water abstracted from Lake Windermere and pumped into T.A.	Continuous abstraction from lake at rate of 12 m.g.d.	12	0·5	58	—	—	Costs assume pressure filtration and chlorination of Windermere water at intake.
10	Bannisdale.	Impounding Reservoir in Bannisdale supplemented by catchwater from Borrowbeck. Treatment at Watchgate. Water delivered to H.A.	Compensation to Bannisdale Beck 1·25 m.g d.	15	4·8	16·9	—	—	Costs assume treatment of water by coagulation, filtration and chlorination. No additional expenditure on H.A. is required.
11	Borrowbeck with Lune Intake.	Impounding reservoir in Borrowbeck supplemented by pumping from River Lune at Tebay. Treatment at Watchgate. Water delivered into H.A.	5 m.g.d. compensation at Borrowbeck dam. No abstraction from Lune at Tebay when flow is 30 m.g.d. or less.	30	7·9	16	Geology at dam site. Fishing.	Scheme suitable for development in two stages. First stage (impounding reservoir only) would yield 15 m.g.d. at a capital cost of £5·5m. and a cost per 1,000 galls. of 18 pence.	Costs allow for full treatment of water from this source also for an expenditure of £1m. on increasing capacity of third line of H.A. to 90 m.g.d. This scheme is an alternative to the Bannisdale scheme (No. 10). If both are constructed the combined yield would be about 35·0 m.g.d.
12(*a*)	Lune Pumped Storage.	Abstraction from Lune downstream of Kirkby Lonsdale, water delivered to pumped storage reservoirs—flood plain treated and delivered (via balancing reservoir) into H.A. & T.A.	No abstraction from Lune when flow at Caton weir is 208 m.g.d. or less.	50	17·2	22·5	Storage capacity required = 8,000 m.g. which would occupy some 850 acres of land in flood plain. Geology at reservoir site. Agricultural.	Scheme suitable for development in stages.	Costs allow for full treatment of water, also for an expenditure of £1·5m. for fourth line on H.A. Hodder and Ribble syphons.

No.	Scheme	Description	Assumed Abstraction Terms	Approx. Net Yield	Approx. Capital Cost	Approx. Cost per 1,000 gals.	Difficulties or Objections	Possible Advantages	Remarks
12(*b*)	Lune with Regulating Reservoirs.	Abstraction from Lune downstream of Kirkby Lonsdale supplemented by regulating reservoirs in Borrowbeck and Upper Lune.	Flow at Caton Weir maintained at not less than 68·0 m.g.d. by releases from Regulating reservoirs. When flow is less than 208 m.g.d. only so much as is then being released from regulating reservoirs to be abstracted.	m.g.d. 48	£m. 10·7	pence 17·5	Geology at both dam sites — particularly Upper Lune site near Kelleth. Properties submerged by Upper Lune reservoir. Agricultural.	Scheme suitable for development in two stages.	Costs allow for full treatment of water, also for an expenditure of £1·5m. for fourth line on H.A., Hodder and Ribble syphons. No allowance made for operational losses in regulation. These will reduce yield and increase cost per 1,000 gallons.
12(*c*)	Lune Estuary.	Abstraction between Skerton weir and Lower Halton weir. Water pumped to small storage reservoir treated and delivered to H.A. & T.A. Flow in estuary maintained by replacing water abstracted by sea-water pumped from Keer channel.	No restriction.	50	7·2	18·5	Quality of water. Position of Intake on river. Sea-water intake.	Suitable for development in stages.	Costs allow for full treatment of water—also for an expenditure of £1·5m. for fourth line on H.A., Hodder and Ribble syphons, and also £0·4m. for sea-water main from sea intake to Skerton weir.
13	Ribble with Regulating Reservoirs.	Abstraction from Hodder at junction with Ribble supplemented by regulating reservoirs in Dunsop, Croasdale and Langden valleys.	ENTIRE YIELD (ABOUT 50 m.g.d.) REQUIRED BY FYLDE WATER BOARD.						
14	Ribble Pumped Storage.	Abstraction between Samlesbury and Calder junction. Water delivered to pumped storage reservoirs in flood plain, treated and delivered into H.A.	(1) No abstraction when flow is 150 m.g.d. or less. (2) No abstraction when flow is 100 m.g.d. or less.	50 50	24·4 16·9	28·3 22·0	Agricultural. 13,000 m.g. storage required for (1) 8,000 m.g. storage required for (2). Lack of suitable sites for storage reservoirs. Geology of reservoir sites. Quality of water.	Suitable for staged development.	Costs assume full treatment and softening of water. The existing capacity of the H.A. and T.A. is adequate south of the point at which water will be injected.

15	Ribble Hellifield.	Abstraction at Ribble-Hodder junction with regulating reservoir on Ribble near Hellifield. Water pumped to treatment works alongside intake and then pumped to T.A. and H.A. at south end of Ribble syphons.	Flow maintained at not less than 86 m.g.d. at Calder junction which is ½ mile below point of abstraction.	85 (or possibly 100).	10	13·4	Agricultural. 3,000 acres required for reservoir. Diversion of main road and main line railway.	Possibility of staged development.	Costs assume full treatment and softening of water. The existing capacity of the H.A. and T.A. is adequate south of the point at which water will be injected.

ESTIMATED DEMANDS AND RESOURCES



Grouping of Sources

Ref. No.		11	10	9A	4B	4A	3	2	1
	Source	Borrowbeck (30)	Bannisdale (15)	Windermere (12) (limited)	Ullswater (22) (no weir)	Ullswater (29) (with weir)	R. Eamont (25)	R. Eden (27)	Caldew (18)
1	Caldew (18)	48	†	†	40	47	43	45	—
2	R. Eden (27)	50+	42	†	*	*	*	—	
3	R. Eamont (25)	50+	40	†	*	*	—		
4A	Ullswater (with weir) (29)	50+	44	41	*	—			
4B	Ullswater (no weir) (22)	50+	†	†	—				
9A	Windermere (limited) (12)	42	†	—					
10	Bannisdale (15)	*	—						
11	Borrowbeck (30)	—							

Notes: † Sources compatible but combined yield less than 40 m.g.d. unless more than "average" yields obtainable from individual sources.

* Sources incompatible for one reason or another.

ANNEX B

REPORT OF THE AMENITY AND PLANNING COMMITTEE

COMMITTEE MEMBERS

J. L. Parkinson, Esq., A.R.I.B.A., M.T.P.I., Dip. Arch. (L'pool). (*Chairman*)

H. M. Abrahams, Esq., C.B.E., J.P.

U. Aylmer Coates, Esq., B.Arch., P.P.T.P.I., F.R.I.B.A.

G. B. Dearden, Esq., B.A., Dip. T.P., A.R.I.B.A., A.M.T.P.I.

Mrs. John Dower, O.B.E., J.P.

R. L. Harrison, Esq., B.Sc., M.I.C.E., M.I.W.E.

K. Steen, Esq., M.T.P.I., A.R.I.B.A., M.I.Mun.E.

Mrs. M. M. Ward. (*Secretary*)

W. R. Wark, Esq., A.R.I.B.A., A.R.I.A.S.

I. INTRODUCTION

1. The Amenity and Planning Committee was set up by the Conference in March 1962, with the following terms of reference:

> To study in detail the effect, on amenities and on other aspects of physical planning, of any schemes of water supply remitted by the Technical Committee, including any possible restrictions on public access: to consider objections that may be made to the schemes on these grounds: and to suggest modifications for meeting them: also to consider ways and means for providing greater public access to Thirlmere.

2. The Committee's eleven members were drawn from:

(*a*) National Parks Commission (2).
(*b*) Lake District Planning Board and Cumberland, Lancashire and Westmorland County Councils (3).
(*c*) Manchester Corporation (3—1 standing member. The other two varied as appropriate).
(*d*) Ministry of Housing and Local Government (3).

At the outset it was made clear to the members that their attendance was not as representatives of the bodies from which they were drawn and that any views expressed by them would not commit their authorities in any way.

3. The Committee first met at Kendal on April 26th, 1962, and have since held six meetings, mostly in the north-west. They have issued four interim reports to the Conference. Altogether they have considered 24 possible sources of water supply; some were variations on a single source. The sites of all of them have been visited. Various experts, chiefly from local authorities, have from time to time assisted the Committee at their meetings and on their inspections.

4. The Conference at their second meeting instructed the Committee to submit their suggestions for consulting various amenity organisations. The Committee proposed that details of the most promising of the acceptable schemes (to the Committee) should be sent to the Council for the Preservation of Rural England, National Trust, Ramblers' Association and Commons, Open Spaces and Footpaths Preservation Society. Subsequently the Conference decided they did not require the Committee to carry out such consultations.

II. CONSIDERATION OF SCHEMES

5. The Committee have reviewed all the possible sources examined by the Technical Committee. They have concentrated on those with a significant amenity or planning interest, including some which were omitted from the Technical Committee's final list. They have also considered the two schemes—Ullswater and Bannisdale—for which Manchester originally sought powers.

6. The Committee's procedure has been uniform throughout. Firstly they examined the data supplied to them by the Technical Committee and discussed the merits of the scheme in a preliminary way; the site was then visited and the Committee decided whether or not the physical alterations likely to be involved were acceptable having regard to the scale and nature of the landscape. Access to the area and its importance from the point of view of public enjoyment were also taken into account.

7. The Committee have not taken the view that a project should be, *ipso facto*, rejected because it is in a National Park, or conversely that there would be no objection if it lay outside one; but they have had constantly in mind that National Parks were designated for the purpose of preserving and enhancing their natural beauty and promoting their enjoyment by the public.

8. Against this background the Committee have considered each case individually on its merits, and decided whether the physical changes imposed would or would not be tolerable in their particular context. The views they have formed on all schemes put to them by the Technical Committee are set out in Schedules A, B and C below.

SCHEDULE A—schemes considered acceptable on amenity and planning grounds on the assumption that details of site, landscaping and design will be agreed with the local planning authorities.

SCHEDULE B—schemes considered unacceptable on amenity and planning grounds.

SCHEDULE C—a number of relatively small local source schemes.

9. The Conference asked the Committee to deal with Ullswater in such detail as they were able to after they had looked at all the alternatives and this appears as a separate item following the Schedules.

SCHEDULE A

SCHEMES ACCEPTABLE ON AMENITY AND PLANNING GROUNDS

Scheme No.	Grid Reference	Name of Scheme	Estimated Yield and Works Proposed	Committee's Views
1	83/351 320	Caldew	Yield: 16–22 m.g.d. Impounding reservoir on the River Caldew. Dam about ¼ of a mile west of the village of Mosedale. T.W.L. 900 ft. (approx.) O.D. if the water is pumped to Haweswater. T.W.L. 855 ft. (approx.) O.D. if the water is pumped to Thirlmere (the aqueduct from Thirlmere would have to be enlarged).	Acceptable subject to satisfactory siting of dam and provision of access to head of reservoir. The valley, though of great beauty, is outside the central core of the Lake District and the perfection of the central Lakeland landscape is lacking.
2	Intake between 83/588 310 577 320	Eden	Yield: 27 m.g.d. (approx.). Intake with underground pipe on the River Eden downstream of confluence with the River Eamont, at Edenhall. A pumphouse, storage reservoir, and treatment plant would be needed. Water pumped to Haweswater via the Heltondale aqueduct.	Acceptable assuming adequate river flow is maintained.
3	83/500 275	Tirril intake from River Eamont	Yield: 18–32 m.g.d. Intake on River Eamont near Tirril. Water pumped to Heltondale where it is treated and conveyed via Heltondale aqueduct to Haweswater.	Acceptable assuming adequate river flow.
9	Intake between 89/385 020 395 995 Banner Rigg: 89/427 995	Windermere	Yield: 48 m.g.d. Intake and pumphouse between the Low Wood Hotel and the Trout Beck. Pipeline to Watchgate via a balancing reservoir on Banner Rigg (T.W.L. c. 750 ft. O.D.). Water delivered to Haweswater and Thirlmere aqueducts.	Scheme acceptable in principle provided the level of the lake is not materially changed. It is important that the water level in the beautiful and much used stretch of the river between Newby Bridge and the lake be maintained. An intake near Calgarth Park with underground pipeline up the Troutbeck Valley and thence to Watchgate is to be preferred.
9A	Intake between 89/385 020 395 995	Windermere limited scheme	Yield: perhaps 15 m.g.d. Intake and pumphouse as in scheme No. 9. Pipeline to Thirlmere aqueduct. A treatment works would be required and its location would depend on decision about treating Thirlmere water. (Pumping house and treatment works would be most convenient by side of lake)	Acceptable subject to treatment works being small and inconspicuous. Otherwise comments as for scheme No. 9 above.
11	89/590 013 Intake (approx.) 83/612 052	Borrowbeck (with Lune intake)	Yield: 30 m.g d. Impounding reservoir on the Borrowbeck. Dam about 2,000 yards upstream of the railway viaduct T.W.L. 800 ft. O.D. Dam height c. 130 ft length c. 1,500 ft. An intake and pumphouse would also be needed on the River Lune near Tebay. Water pumped to treatment works at Watchgate and so to the Haweswater aqueduct.	This valley is outside the finest part of the Lake District and outside the National Park. Whilst still of great beauty there is less variety of form in this area and contrasts are less sharp and a reservoir could be introduced without serious damage. It would be preferable to re-site the dam above the bridge if practicable.
12B	Intake not known. Flakebridge (Kelleth) Reservoir 89/665 050 (approx. only)	Lune with Regulating Reservoirs	Yield: 48 m.g.d. Abstraction from the River Lune downstream of Kirkby Lonsdale (near Gressingbam: exact position not yet known). T.W.L. 775 ft. O.D. Dam height c. 95 ft.	This is an alternative to Scheme No. 12A which is unacceptable. The Flakebridge reservoir would be in a flood plain valley wide enough to take it.

Scheme No.	Grid Reference	Name of Scheme	Estimated Yield and Works Proposed	Committee's Views
12C	Skerton Weir 94/482 638 Lower Halton Weir 94/505 646	Lune Estuary	Yield: 50 m.g.d. Abstraction between Skerton Weir and Lower Halton Weir. Water pumped to small storage reservoir near Claughton and delivered to Haweswater and Thirlmere aqueducts after treatment. Flow in estuary to be made good with sea-water.	No landscape issues are involved.
15	Intake 97/710 382 Dam between 95/833 565 855 545	Ribble: Hellifield	Yield: 85 (or possibly 100) m.g.d. Abstraction from the Rivers Ribble/Hodder at their confluence. Intake (probably weir) pumphouse and treatment works and softening works nearby will be needed. Regulating reservoirs on the River Ribble between Hellifield and Settle and possibly in the Dunsop valley in the Forest of Bowland will also be required. T.W.L. 443 ft. O.D. Height of dam about 80 ft. The Hellifield reservoir will cover approximately 3,320 acres and necessitate diversion of main roads and double-track railway.	Extensive landscaping will be necessary to break up exposed mud flats. Some members considered that the scheme might have scenic and recreational values. There is no objection to the Dunsop valley reservoir as an adjunct to this scheme (see Schedule B, No. 13A).

SCHEMES UNACCEPTABLE ON AMENITY AND PLANNING GROUNDS

Scheme No.	Grid Reference	Name of Scheme	Estimated Yield and Works Proposed	Committee's Views
5	83/435 170	Howe Grain	Reservoir in Bannerdale. T.W.L. 700 ft. O.D.	This scheme affects the Valley of Howe Grain and the smaller valleys of Bannerdale and Ramsgill. The landscape is typical of the central Lake District and is ideal walking country. The valley gives access to High Street one of the finest ridge walks in the country and a reservoir and its ancillaries would be so harmful to the scene as a whole that it must be resisted.
6	82/260 150	Andersonband Crag (Borrowdale)	Yield: 60 m.g.d. Reservoir in Borrowdale. T.W.L. 355 ft. O.D. Dam 100 ft.	In Borrowdale the Lake District landscape is at its best and the construction of a reservoir at Andersonband Crag would have devastating effects. Even in the Lake District itself this is distinguished as a renowned beauty spot. Accessible from the busy holiday centre of Keswick, it is one of the most popular and well-used valleys. All the valley land below the 355 ft. contour would disappear. The villages of Rosthwaite and Stonethwaite would be submerged. Opposition here would be very strong indeed.
8	83/240 000	Duddon	Yield: 13 m.g.d. Reservoir in Duddon Valley. T.W.L. 700 ft. O.D.	Whilst this reservoir site is rather inaccessible from main traffic routes it is much valued by walkers because of its intrinsic beauty. As with Borrowdale the history of earlier proposals clearly indicates that a reservoir would meet with the strongest opposition.
7	83/520 135	Swindale	Reservoir (Private Act powers exist).	Although Swindale is not within the essential core of the Lake District, and has already minor works of water supply, it is a more attractive valley than others on the margins of the Lake District. If storage is the main purpose of this scheme it should be done in less beautiful areas nearer to the user.
10	89/530 015	Bannisdale.	15 m.g.d. Impounding reservoir in Bannisdale. T.W.L. 860 ft. O.D. Dam c. 150 ft. high and c. 1,500 ft. long (concrete). Also works to intercept water from the Borrowbeck near Huck's Bridge. Treatment at the dam in Bannisdale. Water delivered to Haweswater aqueduct.	This valley has considerable natural charm which should not be disturbed.
12A	Intake 89/near Gressingham.	Lune Pumped Storage.	Yield: 48 m.g.d. Intake downstream of Kirkby Lonsdale with storage reservoirs.	These reservoirs would represent a large-scale intrusion which the landscape could not absorb.
12A1	89/550 660 (approx. only)	W. of Claughton	Pond type with encircling dam about 20 ft. high—1,000 acres land would be needed.	
12A2	89/590 710 (approx. only)	W. of Melling.		
12A3	89/600 750 (approx. only)	S.E. of Whittington.		

SCHEDULE B (*continued*)

Scheme No.	Grid Reference	Name of Scheme	Estimated Yield and Works Proposed	Committee's Views
13	95/710 382	Rivers Hodder/Ribble.	Yield: 10 m.g d. Stage I: simple intake from the Rivers Hodder/Ribble. Three further stages with regulating reservoirs:—	Proposed Forest of Bowland Area of Outstanding Natural Beauty (A, B & C).
13A	655 514	Dunsop Reservoir.	Yield: 20 m.g.d. T.W.L. 600 ft. O.D. Dam about 160 ft. high.	Access appears limited by preserve of Fylde Water Board. There would be some loss of amenity and because of its location public opposition must be expected. The landscape of the valley, in the opinion of the committee, might accept a reservoir without great damage but the scheme must presumably be considered in conjunction with 13B and C.
13B	707 541	Croasdale Reservoir.	Yield: 10 m.g.d. T.W.L. 625 ft. O.D. Dam about 100 ft. high.	This is a wide undulating valley with good farms, hedgerows, and small woodlands. A long dam and a wide sheet of water would be very unsympathetic to this landscape.
13C	650 504	Langden Reservoir.	Yield: 10 m.g.d. T.W.L. 540 ft. O.D. Dam about 90 ft. high.	The landscape of this valley would accept a reservoir but only if the water level is kept below the level of the road. A reservoir going above the level of the road would be very damaging in its overall effect.

SCHEDULE C

LOCAL SOURCE SCHEMES

Scheme No.	Grid Reference	Name of Scheme	Estimated Yield and Works Proposed	Committee's Views
B.1	82/160 190	Crummock Water.	Yield: 3·0 m.g.d. Intake Increased abstraction from the lake. No details available.	In the Lake District National Park. It was learned that negotiations were proceeding between the West Cumberland Water Board and the Lake District Planning Board with a view to minimising the visual effect.
B.2	83/298 200	Shoulthwaite (N.W. of Thirlmere).	Yield: 1·5 to 2·0 m g.d. Intake between 610–650 ft. O.D. Tunnel or main to Thirlmere.	In the Lake District National Park. Manchester already have powers to construct these works and no serious damage would be done to the landscape.
B.3	88/280 992	Levers Water (N.W. of Coniston).	Yield: 2·0 m.g.d. Reservoir: T.W.L 1,350 ft. O.D. Existing earth dam.	In the Lake District National Park. A surface pipeline would seriously affect views from the surrounding heights, especially from Coniston Old Man, and there would be strong objection. If this scheme is to proceed the pipeline should go underground. Consideration should be given to the feasibility of impounding the Church Beck below Levers Water. This would have the incidental advantage of flooding waste heaps and other derelict remains of the old copper mine.
B.4	95/908 348	Thursden (E. of Burnley)	Yield: 1·25 m.g.d. Reservoir: T.W.L. 1,050 ft. O.D. Dam about 100 ft. high and 600 ft. long.	An isolated valley which by reason of its scale and form would accept a reservoir without much harm.
B.5	95/860 409	Water Meeting (N.W. of Nelson and Colne).	Yield: 4·0 m.g.d. Reservoir: T.W.L. 565 ft. O.D. Earth dam about 85 ft. high and 1,500 ft long.	Small scale, undulating country with hedgerow trees and some woodland. Attractive landscape very close to Nelson and Colne. A reservoir would be an alien element in this landscape damaging to amenity.
B.6	95/933 393	Wycoller (E. of Colne).	Yield: 1·75 m.g.d. Reservoir: T.W.L. 758 ft. O.D. Earth dam about 75 ft. high and 1,600 ft. long.	A pleasant valley of rather open character with some trees. Below the proposed dam in the vicinity of Wycoller Hall, it is well wooded, very attractive and much visited. It is on the fringe of the Brontë country. There would be some loss of amenity but the damage would not be serious.
B.7	102/052 950	Shelf (E. of Glossop).	Yield: 4·0 m.g.d. Reservoir: T.W.L. 725 ft. O.D. Dam about 110 ft. high and 800 ft long.	In the Peak National Park. Unspoilt valley with a much used footpath. Strong objection on grounds of loss of access.
B.8	111/010 740	Errwood (W. of Buxton).	Yield: 2·7 m.g.d. Reservoir: T.W.L. 950 ft. O.D. Dam about 140 ft. high and 900 ft. long.	In the Peak National Park. A proposal which was put forward some years ago and is now proceeding. The valley is very attractive with much pleasant woodland, valuable and popular for recreation and relaxation. From an amenity point of view the proposal is regrettable. It is noted that a landscape consultant has been engaged to minimise the damage.

III. ULLSWATER SCHEMES (*4A—with weir: 4B—without weir*).

10. The Committee firstly examined Manchester's proposals. They were explained by the Corporation's consultant engineers with the aid of a scale model of the lake and also a diagrammatic model in which water was circulated over an adjustable weir. Charts comparing the natural levels of the lake and the calculated levels which would have resulted from the abstraction scheme, with and without a weir in operation, were placed before the Committee. Subsequently each member of the Committee received and studied similar graphs showing the effects of the two schemes on the water levels in 1949, when there was a dry summer and wet winter, and in 1953 when there was a wet summer and dry winter. They have inspected the lake under a range of conditions and have also examined photographs taken at various times of the year.

11. In August 1962, the Committee sailed round the lake. At the time the level after heavy rain was 478·8 O.D.—about three feet above normal level for that time of the year. Many of the beaches were covered; trees were standing in water and the road was flooded in one place. The unspoilt isolation of the lake and its surroundings, its tranquillity, the freedom of its shores from development, and the outstanding wild beauty of the stretch from Howtown to Patterdale made a great impression on the Committee.

12. The Committee reported to the Conference that they were very anxious about the effects of altering the lake levels on shrubs, trees, and other vegetation growing round the lake and considered an expert opinion (such as that of the Royal Botanical Society or the Nature Conservancy) on the precise effect of these changes was essential.

13. The Conference accepted this report and asked the Committee to give further consideration to the practical effects of the scheme.

14. The Committee, therefore, thoroughly re-examined the whole scheme and submitted a more comprehensive report setting out the facts they had had before them and their findings based on these facts. The report was broadly accepted by the Conference but one or two amendments were suggested to the Committee for consideration. In view of the contentious nature of the problem this report, as amended, is set out in full below.

(a) Facts as to amenity

Ullswater has great natural beauty. It owes much of its charm to the variety of form and contrast in the surrounding landscape; but a feature peculiarly its own is an irregular shore line to which trees and other vegetation, coming down in places right into the water, add great subtlety and interest.

(b) Facts as to lake levels

The level of the lake shown on Ordnance maps is 476·5 ft. This was the level on the day of survey in 1885.

In the winter half of a year with average rainfall the number of days on which the level is below 476·5 ft. is about equal to that on which it is above it. 476·5 ft. may therefore be regarded as the normal winter level (n.w.l.) (see tables 2 and 3). Similarly the normal summer level (n.s.l.) may be taken as 476·0 ft.

Under natural conditions the level of the lake varies between 475·0 ft. and 480 ft. (i.e. from 12–18 ins. below to 3½–4 ft. above normal seasonal levels).

(c) Facts as to Manchester Corporation Proposals

The Corporation want to extract water from Ullswater to secure the maximum use of Haweswater as a storage reservoir. The water is of the right quality for this purpose. Two schemes are broadly envisaged:

(i) With a weir at Pooley Bridge. In this case there would be no abstraction when the lake level is below 475·0 ft. (12–18 ins. below normal seasonal levels). The level of the lake would never be held above 477 ft. (6–12 ins. above normal seasonal levels).

(ii) Without a weir. No abstraction would take place when level falls below 475·4 ft. (some 7–13 ins. below normal seasonal levels).

Abstraction would take place at Gale Bay, the water being pumped underground to the Heltondale aqueduct; thence it would flow to Haweswater with treatment works at Heltondale.

The Manchester Corporation do *not* propose:

- (i) to construct a dam;
- (ii) to restrict access (except as incidental to intake works and underground pumping station);
- (iii) to fell trees or carry out afforestation;
- (iv) to restrict boating, fishing or bathing (except near the intake for reasons of safety) or any other activity;
- (v) to purchase the catchment area, the lake, or attempt to protect the source by this method.

(d) *Facts as to effect of proposals on lake levels*

Manchester have illustrated the effect of the proposals on the lake by reference to the year 1949 which had a wet winter and a dry summer, and the year 1953 which had a dry winter and a wet summer.

They have drawn graphs showing the natural levels of the lake compared with the levels which would have resulted from abstraction of water in accordance with the proposals both with and without a weir. Four sets of controlled conditions were studied:

SCHEME 1. With a weir and flow in the River Eamont as prescribed in the Parliamentary Bill (yield 37 million gallons per day).

SCHEME 2. Without a weir and ditto (29 m.g.d.).

SCHEME 3. With a weir and flow in the River Eamont as requested by the River Board (20 m.g.d.).

SCHEME 4. Without a weir and ditto (15 m.g.d.).

For these years also the following table was compiled showing the number of days on which the lake would be at various levels under natural and scheme conditions.

TABLE 1

Number of Days Lake Ullswater would be at the Stated Levels both under Natural and Controlled Conditions

	475 to 475·5	475·5 to 476	476 to 476·5	476·5 to 477	477 to 478	478 to 479	Over 479
TYPICAL WET SUMMER (1953)							
Natural	—	52	67	37	19	7	1
Scheme 1	66	27	9	50	23	6	2
Scheme 2	71	44	31	16	15	5	1
Scheme 3	2	75	32	51	16	5	2
Scheme 4	1	99	45	17	15	5	1
TYPICAL WET WINTER (1949)							
Natural	12	10	41	42	58	18	1
Scheme 1	16	1	1	90	59	14	1
Scheme 2	16	19	40	36	56	14	1
Scheme 3	10	12	13	72	59	15	1
Scheme 4	12	20	41	37	57	14	1
TYPICAL DRY SUMMER (1949)							
Natural	84	53	30	4	10	2	–
Scheme 1	107	21	10	35	7	3	–
Scheme 2	115	42	11	5	8	2	–
Scheme 3	92	55	9	17	8	2	–
Scheme 4	98	61	9	5	8	2	–
TYPICAL DRY WINTER (1953)							
Natural	10	36	56	43	27	7	3
Scheme 1	3	5	10	116	37	8	3
Scheme 2	34	37	44	33	24	7	3
Scheme 3	8	28	28	72	34	9	3
Scheme 4	13	44	58	36	22	6	3

From these data in Table I a further table has been prepared showing the natural levels in seasons of average rainfall (assuming that the mean values between the wet and dry seasons of 1949 and 1953 represent near average conditions).

TABLE 2

Number of Days Lake Ullswater would be at the Stated Levels under Natural Conditions in Seasons of Average Rainfall.

	475 to 475·5	475·5 to 476	476 to 476·5	476·5 to 477	477 to 478	478 to 479	Over 479
Average summer ..	42	52½	48½	20½	14½	4½	½
Average winter ..	11	23	48½	42½	42½	12½	2
Average year	53	75½	97	63	57	17	2½

From Table 2 the following table was prepared showing the number of days on which the natural level of the lake was above and below 476·0 ft. and 476·5 ft.

TABLE 3

Number of Days Lake Ullswater would be Below and Above 476·0 ft. and 476·5 ft. in Seasons of Average Rainfall.

	476		476·5	
	Below	Above	Below	Above
Average summer ..	94½	88½	143	40
Average winter ..	34	148	82½	99½
Average year ..	128½	236½	225½	139½

Finally Table 4 shows the effect of the schemes on the levels of the lake in terms of extent of variation and frequency.

TABLE 4

Variation from Normal Seasonal Levels Due to Scheme Controls in Wet and Dry Seasons, 1949 and 1953.

Number of days more (+) or number of days less (−) on which the lake would be below or above normal seasonal levels

Level in feet A.O.D.	475 to 475·5	475·5 to 476	476 to 476·5	476·5 to 477	477 to 478	478 to 479	Over 479
Inches below or above normal summer level	12 to 6	6 to 0	0 to 6	6 to 12	12 to 24	24 to 36	Over 36
TYPICAL WET SUMMER							
Scheme 1	+ 66	− 25	− 58	+ 13	+ 4	− 1	+ 1
Scheme 2	+ 71	− 8	− 36	− 21	− 4	− 2	nil
Scheme 3	+ 2	+ 23	− 35	+ 14	− 3	− 2	+ 1
Scheme 4	+ 1	+ 47	− 22	− 20	− 4	− 2	nil
TYPICAL DRY SUMMER							
Scheme 1	+ 23	− 32	− 20	+ 31	− 3	+ 1	nil
Scheme 2	+ 31	− 11	− 19	+ 1	− 2	nil	nil
Scheme 3	+ 8	+ 2	− 21	+ 13	− 2	nil	nil
Scheme 4	+ 14	+ 8	− 21	+ 1	− 2	nil	nil
Inches below or above normal winter level	18 to 12	12 to 6	6 to 0	0 to 6	6 to 18	18 to 30	Over 30
TYPICAL WET WINTER							
Scheme 1	+ 4	− 9	− 40	+ 48	+ 1	− 4	nil
Scheme 2	+ 4	+ 9	− 1	− 6	− 2	− 4	nil
Scheme 3	− 2	+ 2	− 28	+ 30	+ 1	− 3	nil
Scheme 4	nil	+ 10	nil	− 5	− 1	− 4	nil
TYPICAL DRY WINTER							
Scheme 1	− 7	− 31	− 46	+ 73	+ 10	+ 1	nil
Scheme 2	+ 24	+ 1	− 12	− 10	− 3	nil	nil
Scheme 3	− 2	− 8	− 28	+ 29	+ 7	+ 2	nil
Scheme 4	+ 3	+ 8	+ 2	− 7	− 5	− 1	nil

(e) *Inferences from data on levels*

- (i) That the changes in level arising from the proposals fall entirely within the natural range and that significant changes are confined within a range of the lower 2 ft. (i.e. between 475·0 ft. to 477·0 ft.).
- (ii) That all schemes reduce the number of days at which the lake stands at or near normal level (476·0 ft. to 476·5 ft.).
- (iii) That the schemes with a weir increase the number of days when the lake is both above and below normal.
- (iv) That the schemes without a weir reduce all levels, more significantly those below normal.
- (v) That the greatest departures from natural levels occur as shown in Table 4 above. The most notable instances are as follows:

TYPICAL DRY WINTER.
SCHEME 1. 73 days more at 0 to 6 in. above n.w.l.
46 days less at 6 to 0 in. below n.w.l.

TYPICAL WET SUMMER.
SCHEME 2. 71 days more at 12 to 6 in. below n.s.l.
36 days less at 0 to 6 in. above n.s.l.

TYPICAL WET WINTER.
SCHEME 1. 48 days more at 0 to 6 in. above n.w.l.
40 days less at 6 to 0 in. below n.w.l.

TYPICAL DRY SUMMER.
SCHEME 1. 31 days more at 6 to 12 in. above n.s.l.
23 days more at 12 to 6 in. below n.s.l.

(f) *Findings*

- (i) That subject to satisfactory siting and landscape treatment the intake and pumphouse at Ullswater, and the treatment works at Heltondale, are not likely to be harmful to the landscape.
- (ii) That the changes in lake levels brought about by any of the schemes are small. Any injury to amenity would be due to possible ecological disturbance round the fringe of the lake.
- (iii) That a movable weir above the bridge would seriously damage one of the best known of all views of Ullswater. A weir below the bridge, although affecting the flow of water, would be much less harmful.
- (iv) That the noise from the pumphouse could destroy the peace and quiet of a considerable part of the lake, unless effective measures are taken to eliminate it.

(g) *Supplementary observations*

- (i) Some of the members of the Committee thought that if a severe rain storm broke over the lake and its surroundings when the weir happened to be held at 477·0 ft., flooding might occur where it would not have done so bad the lake been at its natural (lower) level. The other members said that this fear was unfounded owing to the large area of the lake and because of the great increase in outflow which could immediately be secured by lowering the weir.
- (ii) The Committee were warned by some members that because of the wholly natural and untouched character of Ullswater and its unique place in public esteem, the strongest objection to any use of Ullswater for the purposes of water supply must be expected. Even if the effect on visual amenity is considered to be negligible, many people will fear the risks of cumulative harmful effects and the possible development of further water works and will consider these risks too great to be undertaken.

IV. NATURE CONSERVANCY VIEWS ON ULLSWATER SCHEMES

15. The Nature Conservancy were asked to advise the Committee on the effect of Manchester's proposals on the marginal vegetation and beaches round the lake and for this purpose were furnished with all the data available to the Committee. At their request the Conservancy were supplied with a list of other possible sources.

16. On Ullswater the report draws attention to the lack of fundamental studies of the problem and states that the Conservancy's views may be modified in the light of further research. Land vegetation can be killed by submergence and water vegetation by more exposure but in practice damage may be limited by the capacity of vegetation to survive a certain amount of change of levels. They are already adapted to fluctuations of levels of up to 4 feet or so. The Conservancy consider, on the information available, that important permanent changes are improbable provided reasonable precautions are observed and there is no deviation from disclosed factors.

17. The Committee had no comments to offer on the report, but the majority considered it corroborated their view that it was possible that the vegetation round the lakeside might suffer as a result of Manchester's proposals and that this could cause some injury to amenity. Other members, however, did not agree with these conclusions pointing out that the Conservancy's report itself suggests that important permanent changes are improbable.

V. ACCESS TO THIRLMERE

18. The Committee considered, as instructed by the Conference, Manchester Corporation's approach to the Lake District Planning Board about their willingness to construct treatment works for Thirlmere and Haweswater and asked to what extent the Board would propose that the public should be afforded further access to the fringe area round Thirlmere and to the lakeside; also what activities the Board would think it right for the Corporation to permit. They learned that the Board had already asked the Planning Officer for Cumberland to prepare a detailed report for them on all matters arising out of the letter. They welcomed the Corporation's letter and were encouraged to hear that the Lake District Planning Board were taking action on it.

19. The Committee subsequently received copies of the County Planning Officer's report, and had no observations to offer.

J. L. Parkinson.
H. M. Abrahams.
U. Aylmer Coates.
G. B. Dearden.
Pauline Dower.
R. L. Harrison.
K. Steen.
M. M. Ward
W. R. Wark.

January, 1963.

Printed in England for Her Majesty's Stationery Office by
McCorquodale, London, S.E.1

A.5636. Wt. 4332/2312. K 40 3/63 Gp. 3309.

MINISTRY OF HOUSING AND LOCAL GOVERNMENT

CONFERENCE ON WATER RESOURCES IN THE NORTH-WEST

LONDON: HER MAJESTY'S STATIONERY OFFICE
1963

CONFERENCE MEMBERS

Earl Jellicoe, D.S.O., M.C.	Chairman
Lord Strang, G.C.B., G.C.M.G., M.B.E.	National Parks Commission
H. M. Abrahams, Esq., C.B.E., J.P.	
R. D. Robinson, Esq. (Consulting Engineer)	
Ald. J. Westoll, J.P.	Cumberland County Council
G. N. C. Swift, Esq.	
Ald. R. S. Crossfield, J.P.	Westmorland County Council
C.Cllor. J. A. Bush	
K. S. Himsworth, Esq.	Westmorland County Council and Lake District Planning Board
J. Kennard, Esq. (Consulting Engineer)	Cumberland and Westmorland County Councils and Lancashire River Board
C.Cllor. K. Dobell, J.P.	Lake District Planning Board
C. Bicknell, Esq., O.B.E.	
Major C. S. R. Graham	Cumberland River Board
R. Birkett, Esq.	
A. J. Collins, Esq.	
Ald. H. Hudson, J.P.	Lancashire River Board
H. Thomas, Esq.	
H. Holmes, Esq.	
Ald. P. Lowe, J.P.	Bolton Corporation
H. R. Davenport, Esq.	
Ald. Miss E. Utley	Burnley Corporation
Ald. M. Williamson	Preston and District Water Board
Cllor. T. Lomas	Manchester Corporation
Cllor. J. McGrath	
P. B. Dingle, Esq., C.B.E.	
R. L. Harrison, Esq.	
N. A. F. Rowntree, Esq. (Consulting Engineer)	